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Title of Thesis — Titre de la thèse:
(~~THE SUBJECTIVE LEXICON IN APHASIC PATIENTS~~)
THE STRUCTURE OF THE SUBJECTIVE LEXICON IN ADULT APHASIC PATIENTS

University — Université: THE UNIVERSITY OF ALBERTA

Degree for which thesis was presented — Grade pour lequel cette thèse fut présentée: M. Sc

Year this degree conferred — Année d'obtention de ce grade 1983	Name of Supervisor — Nom du directeur de thèse DR. L. MARCKWORTH STANFORD

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THE STRUCTURE OF THE SUBJECTIVE LEXICON IN ADULT APHASIC PATIENTS

by

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A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF SCIENCE
IN
PSYCHOLINGUISTICS

DEPARTMENT OF LINGUISTICS

EDMONTON, ALBERTA
FALL, 1983

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ABSTRACT

This study is an experimental inquiry into the nature and structure of the internal representation of concepts denoted by words (i.e., the lexicon) in neurologically impaired individuals. Aphasia is of interest to those who wish to understand the functioning of the brain, to those who wish to understand the structure of language, and to those who wish to diagnose and treat acquired language disorders. The subjective organization of a portion of the lexical field of vegetables is studied using subjects' judgements about the similarity of meaning among eight vegetable terms in the set via three channels (modes of reference), namely, actual objects, pictures of the objects, and verbal labels for the objects. Similarity judgements are meant to capture the concepts in a word as well as to define the range of semantic relations that a word can enter into with other words. To this end, twelve aphasic patients (six anterior/non-fluent and six posterior/fluent) and fourteen normal subjects (necessary for collecting the normative range of simiarity judgement responses), between the ages of 15 and 87 participated in the study.

The subjects were asked to judge the similarity of meaning of vegetable terms, pictures, or objects presented to them via the triadic comparison procedure. These judgement responses were analyzed for each modality by hierarchical clustering techniques, a cluster cohesion statistic (as an indication of cluster cohesiveness), the techniques of multidimensional scaling (MDS) and individual scaling of differences (INDSCAL). Lastly, to examine the degree of differences between the performance of aphasic and normal subjects on the three presentation conditions (modalities), analysis of variance was performed on the data.

Statistically significant results between the performance of aphasic and normal subjects on the three presentation conditions is reported. This significant difference is particularly apparent in the pictures-words paired modalities, primarily attributable to the performance of posterior aphasic patients, who tend to have deficiency in semantic aspects of linguistic processing (i.e., content words in speech).

Results are discussed in relation to the strategies or dimensions employed by the two groups of subjects, upon which they base their similarity judgements of the group of vegetable terms under consideration; and several explanations of performance of the anterior and posterior aphasic patients in comparison to the normal control subjects on the three channels are provided. Suggestions for further research in the area of lexical semantics with pathological populations are also offered.

ACKNOWLEDGEMENTS

I would like to acknowledge and express my gratitude to many individuals who have in diverse ways contributed to the development and completion of this thesis. The following persons, who gave generously of their time and resources, were instrumental in completion of this task.

First and foremost, I wish to express my sincere appreciation to my thesis supervisor, Dr. L. Marckworth Stanford for her constant guidance, abundant suggestions, and generous assistance in completing this thesis. Without her help, the difficulties of completing this project would have been greatly increased.

To other members of my committee, Dr. Gary D. Prideaux and Mrs. Judy Branch, I am also greatly indebted for their constructive advice and suggestions at various phases of this study. Gratitude is also extended to Dr. Wm. J. Baker for his valuable advice and assistance with statistical aspects of the study.

A special note of appreciation goes to the authorities and clinicians in Edmonton, in particular, to Mrs. Judy Branch at the University of Alberta Hospital; to Ms. Elaine M. Heaton and Ms. Linda Mikas at the Glenrose Hospital; and to Mr. R. J. Pinkoski and Ms. Wendy Davis at St. Joseph's Auxiliary Hospital for granting me permission to carry out the experimental part of this study.

Many thanks, of course, must be extended to all the subjects (both aphasic and normal) who participated and cooperated throughout the data collection period. Their whole-hearted cooperation and help made this research possible.

Finally, to my family, I express my sincere thanks for their continued encouragement and support, especially to my parents and grandmother, who instilled in me at an early age a love for learning and the need to persevere. The best is bought at the cost of great pain!

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1. INTRODUCTION

1.1 Preliminaries

> "You hear the words inside your head?" he asked,
> "Well, not exactly 'hear' and not exactly 'see', ---
> There are --- Well, sort of shapes --- and if you
> use words you make them clearer, so that they are
> easier to understand."
>
> --- *The Chrysalids*, John Wyndham.

The purpose of this research is to compare conceptual semantic structure in aphasic patients with that in normal subjects via the subjective lexicon (a term coined and popularized by G. A. Miller (1969), as a way to describe the results of the psychological studies of semantic fields), and its organization. The research was carried out in order to provide some insight into the nature of the effects of aphasia-producing brain damage on the organizational properties of the subjective lexicon (i.e., mental store of lexical items and their associated semantic domains) each individual has for his or her language.

The primary function of language is to convey meaning, and its structural components are related to this function. Morphemes and words are the smallest units of language that carry meaning. Our knowledge of words and their meanings corresponds to a mental lexicon. What we know about words is closely tied to the way we use them to build sentences. In treatments of sentence structure, there has been a traditional distinction between content words and function words. Content words are those that carry the principal meaning of a sentence. They name the objects, events, and characteristics that lie at the heart of the message the sentence is meant to convey and include nouns, main verbs, adjectives, and most adverbs. The number of content words is vast, making up the bulk of our vocabulary. Function words, in contrast, mark grammatical relations among content words in a sentence. They include articles, pronouns, auxiliary verbs and prepositions, and are relatively few in number.

Words per se derive their validity for study from the concepts and relations that they reflect and that make the facts and the structures of knowledge meaningful. As a result, a great deal of attention has been given to the meaning of content words, which have two different kinds of meaning. Denotative meaning is shared meaning, objective in nature, ascribed to a word as a matter of convention (i.e., conditions under which a word may properly be used as agreed upon by the language community), that directs our attention to some object, event, condition, or process. Connotative meaning is private meaning, subjective in nature, possessing both cognitive and affective components that are influenced by personal experiences, associations, and so forth. Comparing the two, the word *home* denotes the place where one resides but may connote safety, comfort and privacy (cognitive or thought component) and joy (affective or emotional component). Whenever a word is used in practice it almost invariably has a more restricted meaning than the whole range of possible meanings.

The organization of a semantic field is assumed to be a function of what a native speaker denotes and connotes about the concepts represented by words and how these concepts are related to each other as a function of the particular situation. The meanings attached to words are concepts representing an individual's organization of reality. While we may be able to form concepts without words, the words of our individual lexicons are the incorporations of concepts for which we have had associated verbal experiences. We use words as stand-ins for images and concepts and manipulate them in lieu of the concepts as we think. Not only does the same word refer to many different concepts in different contexts, but often different words (or phrases) can be used to refer to the same concept. The concept (a mental construct) held by a person is often regarded as the core of the meaning of a particular word employed by the person for the concept. When a language user encounters an utterance, he/she attempts to interpret it using his/her knowledge represented in the subjective lexicon, and his/her experience with similar utterances in similar contexts. Carroll (1964) provides a useful analysis of the relationship among words, meanings, and concepts as follows:

> Perhaps it is useful to think of words, meanings and concepts as forming three somewhat independent series. The words in a language can be thought of as a series of physical entities--either spoken or written. Next, there exists a set of "meanings" which stand in complex relationships to the set of words. These relationships may be described by the rules of usage that have developed by the processes of socialization and communication. A "meaning" can be thought of as a standard of communicative behavior that is shared by those who speak a language. Finally, there exist "concepts"; the classes of experience formed in individuals either independently of language processes or in close dependence on language processes....A meaning of a word is, therefore, a societally-standardized concept, and when we say that a word stands for or names a concept it is understood that we are speaking of concepts that are shared among the members of a speech community. (1964, pp. 186-187)

Describing the structure of the subjective lexicon and experimentally studying lexical meaning has been the task of linguists (Katz & Fodor, 1963; Lehrer, 1974; Lyons, 1974; Palmer, 1976), psycholinguists (Fillenbaum & Rapoport, 1971; Miller & Johnson-Laird, 1976; Osgood, Suci, & Tannenbaum, 1957), and psychologists (Collins & Quillian, 1969; Smith, Rips, & Shoben, 1974; Rosch, 1973, 1975) alike. All of us carry in our minds a vast mental dictionary or subjective lexicon. The meanings of all of the concepts that we know are stored in this subjective lexicon. How are the semantic properties of words organized in our mental dictionaries? Osgood et al. (1957) claim that entries might be distributed in a space along the dimensions derived from the semantic differential. Others, like Collins & Quillian (1969), have suggested that the dictionary is like a network in which the nodes are words and the connecting paths are various types of associative links. Still, another type of organization is based on a semantic feature analysis (Smith et al., 1974).

The lexicon has been assumed to exist in the mind of the ideal speaker-hearer, and lexical organization in the normally intact brain has been extensively examined by different models of semantic processing (also referred to as models of semantic memory). Models of semantic processing have been primarily concerned with the structure of knowledge, with how knowledge is stored, cross-referenced and indexed, with the organization of everyday world knowledge, and with the representation of meaning. Semantic memory is not merely an internal dictionary in which linguistic terms are listed and defined; it also contains our knowledge concerning the meaning of concepts. Concepts are defined by their properties and their relationships to other concepts; and permit us to make generalizations about the world around us without the necessity of directly experiencing every object or event in the environment. Virtually any concept in semantic memory will have multiple relationships associated directly with it. Some concepts are linked with others because they can all be subsumed by another concept. For example, *oak*, *elm*, *beech*, *spruce*, *maple*, and *pine* can be linked under the more inclusive class of *tree*. Some concepts are dependent upon others for their definition and are linked together for that reason; for example, the *volt* is defined in terms of the *ampere* and *ohm*.

The research in this study is based on three assumptions. The first is that the subjective lexicon can be organized into semantic domains (or sets). Lexical items can be grouped into fields or domains on the basis that they share some features or properties. The semantic domain is defined as one which consists of a class of objects all of which share at least one semantic feature in common which differentiates those objects from other domains (Tyler, 1969: p. 8), as for example, the the domain of furniture terms. The domain of furniture includes *chairs*, *sofas*, *desks*, *tables*, *end tables*, and *dining tables*. *Chairs*, *sofas*, *desks*, and *tables* contrast with one another at one level of contrast. *End tables* and *dining tables* though they contrast with one another, are somehow similar in that they are included in the higher-level category *tables*. Likewise, *chairs, sofas*, *desks*, and *tables* (including *end tables* and *dining tables*), though they contrast with one another are somehow similar in that they are included in the higher-level category *furniture*.

The second assumption is that the lexical items are assigned at least a portion of their meaning through their relationships to other lexical items. A third is that the meaning of a lexical item or term is similar for most individuals within their common semantic domain. Language users learn the meaning of lexical items by observing how those words are used in both situational and linguistic contexts. The contexts in which lexical items appear must be sufficiently similar across individuals so that a common meaning is prevalent throughout a given speech community. Furthermore, it is assumed that judgements about lexical items which belong to a particular semantic domain are intuitive (i.e., native speakers have intuitions about the meanings of words, even words they may not ordinarily utilize), and that semantic domains are a basic organizing principle in lexical meaning. That is, most speakers of a language seem to agree on the members of a specific semantic domain (e.g., a *robin* is agreed to be a more typical example of the *bird* category than a *chicken*). Clearly, this organization exists in the minds of the people of a common cultural background who use the category.

The bulk of the research on the subjective lexical organization in normal language speakers has shown that people have strong spontaneous tendencies to organize their knowledge into certain categorical structures, e.g., into categories such as furniture, makes of cars, fruit, vegetables and clothing (Rosch, 1973; 1975), and to use imposed groupings of this kind to aid recall (Mandler, 1967; Tulving, 1962). The speed with which we can answer certain questions may depend on the organizational structure of the knowledge we have acquired. Normal adults typically use their semantic analysis of each word to provide the basis for organizing words into groups. When the items are taxonomically related, the normal adult uses the words' shared categories as the basis for establishing an organizational structure (Tulving & Osler, 1968). These organizational processes are also employed when the words do not share obvious semantic category membership, with groupings based instead on the less salient, shared attributes of the words (Tulving, 1962). Even though there is a common core of culturally shared knowledge, semantic processing is personal because each individual's knowledge and experience differs. How knowledge is arranged determines how we speak and how we understand, how we solve problems and how we remember.

Probably the oldest psychological experiment for probing into the organization of lexical memory is the word association test. The associationist approach represents a long-standing and still vigorous tradition in the psychological study of language. Some psychologists still consider this procedure valid for investigating the subjective lexicon. In the simplest and most classic form of the word-association test, the subject is presented with a series of stimulus words and instructed to respond to each one with the first word (or words) that occur to him or her. The nature and grouping of the elicited response words is assumed to reveal the underlying semantic organization. Almost neglected in this research on lexical items was the larger picture of how the human mind transformed these verbal units into an organized structural network. More recently, the approach to semantic processing has shifted from the associationist viewpoint to a cognitive viewpoint. The two points of view share many characteristics, but emphasis in the latter view has been on the delineation of detailed cognitive structures that represent the way semantic information is organized in memory.

From the standpoint of the cognitive perspective, the position taken in this study, the researcher is concerned with what is going on inside a person's head when he or she is performing some task, that is, with mental processes and the way a person stores knowledge and uses it in performing some task. Since meaning, a mental phenomenon, is in the minds of language users and by its very nature is impossible to study directly, one must devise scientific methods to observe it indirectly, so that the semantic organization in the mind of an individual language user may be revealed. One particular experimental technique, the semantic similarity measure, gives an experimenter an objective basis for studying the organization of semantic domains, while at the same time allowing him or her to formulate inferences about mental functions. Semantic similarity experiments reveal the underlying properties which lexical items have and how particular semantic domains are organized. Although judgements about which lexical items belong to a particular semantic domain are intuitive, most speakers of a language seem to agree on the members of a specific domain, and on which terms seem central to a particular domain and which are peripheral, because they have developed a concept about the prototypicality of certain terms (Rosch, 1978). Recent efforts based on semantic similarity word ratings have concentrated on words within specific categories such as colour terms (Berlin & Kay, 1967; Fillenbaum & Rapoport, 1971), emotion names (Fillenbaum & Rapoport, 1971; Magnera, 1982), the *have* verbs (Fillenbaum & Rapoport, 1971), and verbs of judging (Fillenbaum & Rapoport, 1971; Fillmore, 1971; Magnera, 1977; Marckworth, 1978).

1.2 Objectives of the Study

The objective of this study was to investigate the semantic structure presumed to be embodied in the lexicon of aphasic subjects, as compared to non-aphasic normal control subjects. Language functioning includes such decoding skills as understanding what is said and what one reads and the encoding skills of speaking and writing. Aphasia is an impairment of some or all of these language functions after one has suffered brain damage from a stroke or other brain trauma. As such, it cuts across all language modalities, occurring in a variety of forms ranging in severity from minimal word-finding difficulty to a complete inability to comprehend or produce spoken or written language, but always "disproportionate to impairment of other intellectual functions" (Darley, 1969). Aphasia can result from numerous causes ranging from head injury to tumor. The predominant cause of this disorder of language, however, is a cerebrovascular accident (CVA) or stroke. In the great majority of humans affected this arises from damage to any of several regions of the left (dominant) hemisphere. By definition, prior to sustaining brain damage, aphasic subjects' relevant neurological development and status were within normal limits; their pre-morbid language development and mature skill was consistent with their general intellectual and educational level. Recovery from aphasia is affected by many factors, including the etiology, locus and extent of the lesion, the type and severity of aphasia, the time elapsed since its onset, and the age, and educational level and motivation of the patient (reviewed in Darley, Aronson, & Brown, 1975).

Yet while it is true that no two aphasic patients are exactly alike, there are clinically observable patterns of language dissolution associated with focal damage to specific parts of the language-dominated hemisphere. Lesions in different areas of the hemisphere lead to qualitatively distinct syndromes. Although there is no uniform criterion for classifying types of aphasia, the consequence of which is considerable terminological diversity, widely accepted general categories of aphasia have been established. Generally, lesions involving the anterior portion of the language area of the brain produce non-fluent, expressive aphasias. Lesions involving the posterior portion of the language area produce fluent, receptive aphasias. But no classifiction is entirely satisfactory because of the wide range of symptoms that exist, their interrelationships, their range of severity, and their relationships to deficits of other kinds, e.g., to physical, motor, and intellectual deficits.

Since most adults who acquire aphasia still retain partial language functions, the term *dysphasia* (reduction of language functions) is often used to describe the language loss. In spite of the fact that the term *dysphasia* is the more accurate one, the term *aphasia* is used more widely. Throughout this thesis, we will follow the commonly accepted practice of using the term *aphasia*, although its strict meaning denotes absence of the ability to articulate and understand ideas, a condition found only in extremely severe adult cases or children who have failed to acquire speech.

The task of establishing the parameters of lexical storage in aphasia has been attempted, in particular to determine whether or not word-finding difficulties can be traced to restrictions in lexical knowledge and organization. The results of these studies have, in some cases, been interpreted as demonstrating alterations or deficits in the semantic organization of the lexicon of these patients (Goodglass, 1973; Grossman, 1978, 1981; Zurif & Caramazza, 1976). In addition, it has been suggested that abstract words present more difficulty to aphasic patients than concrete words (Goldstein, 1948), and that aphasic individuals tend to categorize words in a relatively concrete-emotional manner when compared to non-aphasic individuals (Zurif, Caramazza, Myerson, & Galvin, 1974). Granted that is the case, it seems appropriate in this study to determine how the subjective lexicon might be organized under conditions of language deficit due to brain damage sustained after the language has been established. In particular, the study attempts to determine how aphasic patients organize or structure concepts in a category of concrete nouns by accessing those concepts by three types of channels (modes of reference): lexical items, i.e., verbal labels of the object; actual examples of the object; and pictures (another abstraction) of the object. The assumption is made, and tested, that a normal subject will exhibit similar concept structures in all three accessing modalities, and a group of normal subjects will exhibit a shared underlying dimensionality of a semantic domain. By comparing the behaviour of aphasic subjects to normals we can thus see whether the verbal channel is what is disturbed in aphasics, or the conceptual structure, and whether this is affected by aphasic type. More specifically, this study obtained and analyzed data in order to answer the following questions:

1. Do normal and aphasic subjects organize their subjective lexicons on a semantic similarity of meaning task differently within and across the three accessing modalities?

2. Do anterior (non-fluent) and posterior (fluent) aphasics organize their lexicons on a semantic similarity task differently within and across the three accessing modalities?

3. When aphasics and normal language speakers are asked to judge meaning similarities of words from a particular semantic domain (i.e., a set of vegetable terms), what strategies or dimensions do they employ upon which they base their similarity judgements of the lexical items under consideration?

4. Is there any difference between the way the two groups of aphasics (anterior/non-fluent) and (posterior/fluent) process concrete representations of the objects (real objects) from that of the abstract representations of the objects (pictures and verbal labels of the objects)?

Judgements about semantic similarity of words have frequently been used for exploring structures of particular semantic fields (Fillenbaum & Rapoport, 1971; Magnera, 1977; Marckworth, 1978; Pelletier, 1978). From the judgements one can discover the complex semantic structure on which the judgements are presumably based, for what is grouped together in the lexicon is taken to be indicative of its structure. The assumption is that if subjects judge two words to be similar in meaning, these words must share some properties or dimensions. For such data, various methods of classification and scaling procedures for ascertaining the dimensions of meanings of groups of terms have been utilized, the most common being hierarchical clustering analysis and multidimensional scaling, which reveal shared patterns of organization for a particular semantic set. Such bases are assumed to be the semantic dimensions of the lexical set under consideration, upon which speakers and hearers manipulate lexical choices during the production or comprehension of an utterance. For instance, Magnera

(1977), who investigated verbs of judging using the semantic similarity rating technique, found that the set of words were structured into two major categories: positive evaluations versus negative evaluations. Each of these categories was still further subdivided into two groups: mildly negative verbs (e.g., *chide*, *criticize*, *scold*) versus strongly negative terms (e.g., *blame*, *convict*, *discredit*), and mildly positive terms (e.g., *acquit*, *excuse*, *forgive*) versus strongly positive terms (e.g., *acclaim*, *accept*, *praise*).

In a similar vein, the subjects in the study reported here were asked to make similarity judgements of set of eight lexical items from the semantic domain of vegetables. The experimental condition consisted of three subtests in which the vegetable category was presented to subjects in three modalities: the actual objects, pictures of the objects and verbal labels for the objects. In each subtest, the aphasic and non-aphasic subjects were presented successive sets of triads of words, pictures or objects from the set and were asked which two words/pictures/objects were most alike. It was assumed that in order for a subject to settle on two choices in any one triad, he or she had to ignore some of their distinguishing feaures or dimensions while attending to others. By analyzing the resultant clusters, we can assess which features or dimensions were attended to and therefore, indirectly discover which features or dimensions are central to the subjective lexicon accessed through a given modality.

1.3 Overview

Chapter Two consists of a review of the literature on the nature of the subjective lexicon pertinent to both the aphasic and non-aphasic populations. In Chapter Three the details of the experimental design, a criterion for selecting the aphasic population, and the nature of techniques and statistics employed for the analysis of the data are described. The results of the experiment via statistical techniques are discussed in Chapter Four. Chapter Five summarizes the main findings of the present study, discusses the implications of these results, and in the light of this research, offers some suggestions for further research in the area of the subjective lexicon in pathological populations.

2. A REVIEW OF STUDIES ON THE SUBJECTIVE LEXICON

2.1 Introduction

> "When I use a word," Humpty Dumpty said in a rather scornful tone, "it means what I choose it to mean -- neither more nor less."
> "The question is," said Alice, "whether you *can* make words mean so many different things."
> "The question is," said Humpty Dumpty, "which is to be master -- that's all."
>
> --- *Through the Looking Glass*, Lewis Carroll.

The words we know are part of our subjective lexicon and must be stored and organized in such a way that we can find them when we need them. The study of meaning has been of interest to a wide variety of disciplines: anthropology, linguistics, philosophy, psychology, psycholinguistics, and speech pathology. Efforts to answer questions such as, what is in the mental lexicon, how is it organized, and how do we go about finding the items that are stored there have been attempted by a number of investigators. This chapter is devoted to a comprehensive review of the various approaches to the study of the nature and organization of the subjective lexicon, pertaining to both normal language speakers and aphasic populations. The first section of this chapter examines the lingustic, psycholinguistic, and psychological approaches to the study of meaning structure of words as they relate to normative subjects; the second section of the review examines important issues in aphasic research and surveys the current literature on the nature of the subjective lexicon and its organization in aphasic patients.

Given that the communication of meaning is the central function of language, we might expect semantics to be the most well-developed branch of linguistics. Unfortunately, semantic studies have lagged behind most other aspects of linguistic investigation, partly because of the linguist's preoccupation with structure, and partly because of fundamental difficulties in subjecting the notion of "meaning" to successful analysis. Indeed, certain common themes have emerged in the literature which can help to distinguish linguistic semantics from other, more well-established approaches to the study of meaning, in particular, those which stem from philosophy and psychology.

Philosophers have maintained an interest in problems of semantics for centuries. While questions of meaning may be separated into notions about word meaning and notions of meaning of complete sentences, the study reported here in particular deals with word meaning. This is in contrast to the philosophical approach, which deals with utterance meaning. The oldest theory of meaning, dating at least from Plato, is that the meaning of a word is the object for which the word stands (e.g., the meaning of *Fido* is the dog who is so labeled). Since that time, a strong philosophical tradition for the study of meaning has developed, most recently under such headings as "semiotics" and "philosophy of language". The philosopher's approach has been primarily concerned in establishing the conditions under which linguistic expressions can be said to be true or false in relation to the external world, and the nature of the factors which affect the interpretation of language.

In addition to the studies of the internal structure of linguistic expressions, the philosophic tradition has focused attention on the various uses to which language may be put, and on the several factors which contribute to the total interpretation, or signification, of the message. These factors, the "meanings of meaning", as they are sometimes called, have been variously labelled. When emphasis is on the relationship between language, on the one hand, and the entities, events, states-of-affairs, etc., which are external to the speaker and his/ her language, on the other, terms such as "referential meaning", "denotative meaning", and "extensional meaning" are used. Secondly, when the emphasis is on the relationship between language and the mental state of the speaker, two types of terminology are used: the personal, emotional aspects are handled by such terms as "affective meaning" or "connotative meaning"; the intellectual, factual aspects involve such terms as "cognitive meaning" or "ideational meaning". Thirdly, when the emphasis is on the way variations in the extra-linguistic situation affect the understanding and interpretation of language, terms such as "social meaning", "interpersonal meaning", or "situational meaning" have been used.

2.2 Linguistic Approaches to Meaning

Within traditional language studies, semantics has generally been thought to involve two areas of study. First, there is the study of meaning in historical terms, the description and classification of the changes of meaning which affect the words in a language. Tracing these changes back to the earliest appearance of a word in any language (etymology) is one of the oldest traditions in the study of meaning. Secondly, there is the provision of an inventory of the forms and meanings of a language, in dictionaries and thesauri. The compilation of dictionaries (lexicography) is again a long-standing tradition in the history of the study of linguistics. Anthropologists, linguists, and psychologists alike have tended to adopt one of two general approaches in their analysis of meaning. Field approaches are generally based on the word as the analytic unit, and meaning is analyzed in terms of relationships between words. By contrast, the atomic approaches attempt to break down the meaning of a word or a larger linguistic unit into more elementary features or components.

2.2.1 Semantic Field Analysis

An influential view of lexical organization is that based on the notion of semantic fields: vocabulary is said to be organized into areas of meaning, within which lexemes (i.e., the underlying, minimal units of vocabulary, and thus of semantics (cf., "phonemes" in phonology), "word" being then reserved for grammatical use), interrelate and define each other in various ways.[1] The semantic field theory derives from the work of the German linguist Trier (1934), the Swiss linguist de Saussure (1959), and a number of American anthropologists. It attempts to describe the relations that exist among closely related terms with the notion that the meaning of a given term depends on what it can do when compared with other terms within the same class. For example, in the semantic field concerning *sheep*, de Saussure argued that the English word sheep must have a different meaning from the French word *mouton*, since there is an English word, *mutton*, for the flesh of sheep served as a meal, whereas there is no comparable term in French. Therefore, *mouton* in French must have a broader meaning than *sheep* in English, since *mouton* must include that portion of the semantic field that is occupied by two terms in English, *sheep* and *mutton*. Or to take another much-studied example, the lexemes denoting colour define one semantic field: the precise meaning of a colour term should be understood only by placing it in relation to the other terms which occur with it in demarcating the colour spectrum.

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[1] It should be noted that a different sense of "semantic field" is found in the neuropsychological use of the term by Luria (1964), where it refers to the sound and meaning associations of a word with other words, as determined by the physiological measurement of orienting reactions. Lesser (1978) also prefers a more general sense for this term, using "semantic category" in its place.

In the 1950's anthropological linguists introduced the technique of componential analysis in order to solve some of the semantic problems they faced in working with different linguistic groups (Goodenough, 1956, 1965; Lounsbury, 1956). They employed the technique in an attempt to discover the ultimate meaning units of which a particular set of words appears to be composed in some systematic way. Anthropological studies of semantics have typically examined particular semantic domains such as kinship terms (Romney & D'Andrade, 1964; Wallace & Atkins, 1960), colour terms (Berlin & Kay, 1967), or sets of terms for classifying natural phenomena such as animals, diseases, meterological phenomena, and supernatural beings (gods, ghosts, etc.) (Burling, 1970). Through componential analysis, one seeks to find out how speakers use the vocabulary of a language in order to classify reality by referring to certain parameters of meaning. By examining such a system as the words a speaker uses to name various relatives, one can establish how parameters such as sex, age, consanguinity, and generation are used to provide componential meanings for the system. The distribution of such meanings in the system is likely to correlate with certain social patterns. The research in this study is an experimental version of componential analysis via semantic similarity measures.

In another approach, Lyons (1977) has presented a set of intuitively derived relational tests to be applied to the analysis of a given semantic field. Of these sense relations, the most regularly cited in the semantic literature are opposition (e.g., *high-low*), incompatibility (e.g., *general-private*), synonymy (e.g., *fall-autumn*), hyponymy (e.g., *bird-robin*), and part-whole (e.g., *arm-body*). Of course, other distinctions are possible and some of these relations can be sub-divided, but these sense relations seem to be the principle components needed for describing the structure of semantic fields.

Semantic field theories often proceed as did Lyons, by producing taxonomies that serve to organize part or all of the terms in the field under consideration. Table 2.1 presents a taxonomy of sound words presented by Lehrer (1974:36). Notice how some of the relations described previously serve as the basis for the distinctions in Table 2.1. *Audible-inaudible* and *loud-soft*, for instance, represent oppositional relations; *silent-quiet* is synonymy and *noise-din* is hyponymy. The method of constructing semantic-field taxonomies involves the intuitions of the theorist buttressed sometimes by the judgements of informants. In essence, the method seems to consist of an intuitive decision as to what a field is, for example, sound words; an attempt to produce an exhaustive list of terms that fall within that field and an effort to determine the relations that exist among the terms consistent with the types of distinctions made, for example, by Lyons. A display of these sense relations is found in Table 2.1.

TABLE 2.1

Taxonomy of Sound Words

Audible			Inaudible
Loud →		Soft	Silent (=quiet)
Noise	Pleasant Sound		
din	resounding	hushed	hush
racket	resonant	muffled	
clamour	sonorous		
crash			
clatter			
rattle			
strident			

As these methods are practiced by linguists, there does not seem to be any measure for deciding among various realizations of the structure of a semantic field or any explicit attempt to relate field structures to psychological reality. Though the taxonomy in Table 2.1 has as its first division *audible* versus *inaudible*, one could as easily make the initial division along the lines of *pleasant* versus *unpleasant*. Lehrer (1974) reports, in fact, that she had subjects sort cards with the various sound terms written on them into any number of piles in any way that they thought to be appropriate. She reports that the *loud* versus *soft* distinction was the most frequent, followed by *pleasant* versus *unpleasant* and *continuous* versus *sudden*. Note that the *continuous* (e.g., *racket*) versus *sudden* (e.g., *crash*) distinction is not even marked in Table 2.1.

Semantic field theories have been used to analyze various concrete and abstract lexical groupings, such as colour terms, kinship terms, motion verbs, possession verbs, verbs of judging, and sound terms. Given that these theories make no psychological claims for particular taxonomies, the approach seems to be a useful way of organizing some of the knowledge that sophisticated adult speakers have about sense relations among closely linked terms. Needless to say, as a linguistic approach to the problem of semantic structure, semantic field theories have been criticized because the structural picture they portray is too simplistic in nature (see Ullmann, 1962). Except in such well-defined spheres as colour and kinship terms, lexical units seem structured much more loosely and less systematically than the semantic field theories imply.

2.2.2 Analysis Based on Semantic Features

As opposed to the semantic field theories of meaning, semantic feature theories (Bierwisch, 1970; Katz & Fodor, 1963; Weinreich, 1966), on the other hand, do have psychological pretensions, although their basis may still be intuitive and not seen as needing empirical verification. The meaning of words in the subjective lexicon in feature theories is based on an analysis of word meanings into collections of semantic components or features. This general approach closely parallels the distinctive feature approach to the analysis of linguistic sounds. Like phonological features, semantic features are conceptualized as abstract elements which are the building blocks of word meaning, and as in phonological analysis, the descriptive terms for a feature are designated by binary opposites: animate-inanimate, common-proper, human-nonhuman and concrete-abstract. Since the features may be hierarchical, so that one subsumes another, each relevant feature need not always be stated explicitly.

These atomic features, it is thought, can explain the sense relations that are captured in the field theories, as well as determine whether a sentence is semantically ambiguous or anomalous, and determine the existence of paraphrase and synonymy. The mechanism for achieving these goals is a set of binary contrasts that can be understood by referring to the following much-used example (Lehrer, 1974:46).

man	woman	child
bull	cow	calf
ram	ewe	lamb
	etc.	

A whole system of relationships can be established along these lines, all of which can be analyzed in terms of the components *male* versus *female*, *adult* versus *non-adult*, and *human* versus *bovine* versus *ovine*. One of the members is then used as a base form, the constrast being signalled through the use of plus or minus, e.g., *man= +male*, *+adult*, *+human*, or *-female*, *-child*, *-animal*. The inapplicability of a distinction can then be marked using ±. Each label has a unique pattern of features associated with it and presumably, therefore, a unique meaning.

Inspite of the fact that semantic feature analysis has been used effectively for several kinds of terms, especially kinship terms, which constitute one of the most-studied of semantic domains, there are problems which reduce the plausibility of this approach. How do we handle lexical constrasts which are not binary (e.g., complementary and incompatible terms)? The words *girl*, *boy*, *woman*, and *man* can be analyzed into a set of binary features, but many terms cannot be analyzed into a set of binary features. For instance, the application of feature analysis to domains of animal names or metals (copper, gold, iron, zinc, and so on) fails to produce a complete description of the way in which people in a particular culture think about the concepts in question. In fact, it may be that kinship is one of the few semantic fields for which it is possible to provide a complete description by the application of feature analysis. The number of primary terms in kinship structures is generally limited, and the features that specify those terms are likewise limited in number.

Another evident problem is that only certain word groups lend themselves to such an analysis (e.g., to what dimensions might the language of facial expressions be reduced?). Verbal classes with such ill-defined boundaries have been called "fuzzy categories" (e.g., Rosch, 1973). In fact, there are many things in the world we are unable to talk about using single lexemes, forcing us to resort to vague modifiers (e.g., *very*, *quite*, *sort of*, *kind of*) and empty fillers (e.g., *sort of thing*, *whatsit*). Wittgenstein (1953) argued that a category such as *games* has no attributes that are shared by virtually all its members, even though different subset of games may have common properties that are shared by all games. Games such as chess involve boards, whereas others, such as squash do not. Some games involve cards; others involve balls, racquets, bats, and so on. Still others such as tag, require no equipment at all. Many games have winners and losers, but others, such as catch or frisbee, do not. This suggests that *games* and other fuzzy terms cannot be handled by feature analysis.

2.3 Psycholinguistic Approaches to Meaning

2.3.1 Osgood's Semantic Differential

The semantic differential, first introduced by Osgood and his colleagues (Osgood, Suci, & Tannenbaum, 1957), specifically invented for psycholinguistic purposes, is the best known technique for the investigation of lexical meaning systematically. The semantic differential approach measures the connotative meanings of words for individual speakers of a language. In adopting the behavioristic orientation towards semantics, Osgood identifies meaning with the pattern of responses that have become associated through learning with a stimulus which may be linguistic or not (objects), and the responses may be verbal or nonverbal.

The semantic differential, as the measuring instrument came to be known, consists of a series of rating scales, each of which is anchored at its two ends by a pair of bi-polar adjectives, upon which test words are evaluated. The similarities among the ratings of various words are then determined by the statistical procedure of factor analysis. This procedure creates a space within which various words can be placed; the closer the two words are to each other in the space, the more alike they are said to be in meaning. Words like *good*, *beautiful*, *clean*, and *pleasant* tended to cluster together in this space, and tended to be distinct from other clusters such as *bad*, *ugly*, *dirty*, and *unpleasant*.

Factor analysis of the ratings of various words against a large number of scales in more than twenty-five different linguistic communities around the world has consistently resulted in a set of three major dimensions of connotative meaning of words: evaluation (e.g., *good-bad*, *beautiful-ugly*, *fair-unfair*, *kind-cruel*), potency (e.g., *strong-weak*, *hard-soft*, *heavy-light*, *large-small*), and activity (e.g., *active-passive*, *quick-slow*, *excitable-calm*, *slow-fast*). Since the rating of a concept on any one of these three dimensions is not necessarily related to its rating on either of the other dimensions, the dimensions are theoretically independent (e.g., one can have a concept like *mosquito*, which might be rated as bad, active and weak; or a concept like *honeybee*, which might be rated as good, active and weak). Any combinations of evaluation, activity, and potency ratings are possible. Osgood reasoned that these three dimensions are so universal because of the importance of emotion in human affairs; all people seem to react emotionally in the same general ways. This is not to say that specific concepts are rated in the same ways.

While the semantic differential has proven to be a useful and popular research tool, it has several shortcomings. One of the most serious is that the concept being rated at a particular time may influence the interpretations placed upon the various rating scales (Carroll, 1964; Weinreich, 1958). For example, while the scale healthy-unhealthy is usually interpreted figuratively and thus elicits ratings that correlate with the evaluative cluster (*good-bad*, *kind-cruel*, etc.), a person asked to rate a specific concept may interpret the scale in its *denotative* sense (presence versus absence of physical well being) and may, accordingly, characterize her ailing father as being unhealthy, but kind, honest, and so on. This example, showing the impact of a particular concept on the interpretation placed upon a given rating scale may be quite common, leaving us to wonder if the semantic differential does, in fact, measure "pure" connotation. It seems more reasonable to assume that the semantic differential elicits an unknown mixture of connotative and denotative reactions. Moreover, there are questions regarding the generality of the three-dimensional meaning space (Carroll, 1959) in that by altering the sample of scales and the samples of concepts presented for rating, we may drastically affect the number and character of the semantic dimensions that appear. Despite these limitations, the semantic differential has proven to be a very flexible research tool.

2.3.2 Semantic Similarity Word Ratings

While the semantic differential was intended to deal with all the words in the lexicon, semantic similarity ratings are meant to capture the concepts in a word as well to define the range of semantic relations that a word can enter into with other words. Research on similarity word ratings has concentrated on words within specific categories such as colour names (Fillenbaum & Rapoport, 1971), emotion names (Fillenbaum & Rapoport, 1971; Baker, personal communication), *have* verbs (Fillenbaum & Rapoport, 1971), possession verbs (Bendix, 1966; Fillmore, 1969), motion verbs (Miller, 1972), cooking verbs (Lehrer, 1969), verbs of judging (Fillenbaum & Rapoport, 1971, 1974; Fillmore, 1971; Magnera, 1977; Marckworth, 1977), and sound terms (Lehrer, 1974).

Fillenbaum and Rapoport (1971) attempted to characterize the semantic structure of the subjective lexicon of diverse semantic domains ranging from pronouns and kinship terms to verbs of judging and evaluative adjectives (e.g., *good-bad* terms). They constructed word lists for each of the semantic domains and for each of these lists asked people for a variety of similarity judgements among pairs of words within a domain. Using these similarity judgements and a variety of analytic techniques, Fillenbaum and Rapoport found that even though inter-subject agreement is quite good for grouping kinship terms, individuals tend to differ in their judgements about other kinds of words. Some domains like prepositions were best represented by hierarchical organization. Prepositions could not be arranged in an interpretable space, but they could be organized into interpretable clusters or groups: *behind*, *down*, *below*, and *under* formed one cluster, whereas *across*, *over*, *up*, and *on* formed another. Still other semantic domains (e.g., evaluative adjectives and emotion terms), defied analysis. Evaluative adjectives showed little structure beyond the basic *good-bad* opposition, perhaps because any subtler meanings of these words must be inferred from the nouns they modify.

The emotion terms produced the largest differences among the similarity judgements. When Fillenbaum and Rapoport administered Hebrew emotion terms to Hebrew speaking subjects, unfortunately they interpreted their results as if they were valid for English emotion terms. Since their analysis failed to show a clear structure beyond the basic pleasant-unpleasant dimension, they speculated either that we do not have a commonly shared inter-personal set of organizing principles for emotion terms, or the analytic techniques tried thus far are inappropriate for discovering a common underlying structure for this semantic domain. Magnera (1982), however, offers a more plausible explanation of this data:

> Under the circumstances of their study it is hardly surprising that their results were inconsistent. Israel has a heterogeneous population of people immigrating there from all over the world. The discrepancies in Fillenbaum & Rapoport's data could result from cultural differences....It is a serious mistake to ignore cultural and linguistic background in a semantic study as Fillenbaum and Rapoport have done. (pp. 181-182)

More recently, results from Baker's study (personal communication) and from one of the pilot studies conducted by this investigator (1980), indicate that English emotion terms indeed reflect a subtle organization beyond the basic pleasant-unpleasant dimension. Two additional dimensions emerged from analysis: outward directed (e.g., *affection*, *joy*, *anger*, *envy*) versus inward directed (e.g., *anticipation*, *excitement*, *sadness*, *worry*) terms, and passive (e.g., *happiness*, *love*, *envy*, *apathy*) versus active (e.g., *anticipation*, *surprise*, *anger*, *grief*) terms.

Of the methods of analysis that have been applied to semantic studies, multidimensional scaling has been more widely used than any other procedure because of its success in analyzing and depicting similarity relationships of category terms in a plausible spatial representation. It has been applied to many semantic domains including colour terms, kinship terms, pronouns, emotion names, prepositions, conjunctions, judgement verbs, possession verbs, trait names, occupation names and others (see Fillenbaum & Rapoport, 1971; Romney, Shepard & Nerlove, 1972). This mathematical technique represents the degree of similarity between the members of a set of items by the distance between them in a similarity space using proximities among any kind of objects as input. A proximity can be the number which indicates how similar or how different two objects are, or are perceived to be, or any measure of this kind. The chief output is a spatial representation, consisting of a geometric configuration of points as on a map. Each point in the configuration corresponds to one of the objects. This configuration reflects the "hidden structure" in the data. The larger the dissimilarity (or smaller the similarity) between two objects, as shown by their proximity value, the further apart they should be in the spatial map. The goal is to find the best spatial representation that fits all the tested pairs from a semantic domain simultaneously.

From the configuration(s) derived from multidimensional scaling it is often possible to determine, with some degree of intuitive satisfaction, the principle dimensions which subjects use in judging the degree of similarity among words in some semantic field. For example, Henley's (1969) study of similarity judgements among animal names revealed two primary dimensions, ferocity and size, anchored by the contrast of *tame-ferocious* and *large-small*. Spatial representations of similarity are often very useful, especially since they make it easy to see all at once how similar the various pairs of items are and why. Of course, it is unlikely that people have something like a "map of animal terms" stored in their heads. A similarity space is simply a convenient way to represent people's intuitions about the similarites between the various pairs of items and about the dimensions which organize the set in terms of meaning.

2.4 Psychological Approaches to Meaning

Psychologists' attempts to study lexical meaning experimentally, if not extensions of linguistic approaches, at least reflect a strong influence by them. These linguistically-oriented approaches use linguistic semantic concepts such as features, propositions and case categories, along with syntactic constructs. The main issue that has preoccupied psychologists has been whether word meanings and the relationships among them are stored explicitly in memory or whether they must be computed afresh whenever needed.

Several approaches or models of semantic processing take constrasting positions in their attempts to investigate what people actually store in their mental lexicon.

2.4.1 Organizational Structure in the Subjective Lexicon

There are several ways in which information may be organized. The way in which the items (e.g., on a grocery list) are organized will aid in recalling individual items. Some concepts are associated with one another (e.g., milk and cereal). Others are categorically organized (e.g., produce: lettuce, carrots, and tomatoes). Still others (e.g., facial tissue, shampoo, and soda pop) may have been organized idiosyncratically. The form the recall takes says something of the way we organize words and thereby gives us a clue to the nature of cognitive structure. By examining the order in which the items are recalled, we can assess the basis for organizing input.

2.4.1.1 Categorical organization

The pioneer work on category organization has been done by Bousfield (1953), who studied how people learn and recall lists of categorized words (e.g., words drawn from four distinct categories of animals, names, vegetables, and professions), and noted that an important pattern occurred. The acquired words were presented in a random order, but people did not recall them in a random order. Rather, they tended to recall a set of words from one category, then from another category, and so on. The results indicated that lists of thematically related words tended to be recalled in clustered sequences (e.g., *dog*, *cat*, *lion*, etc.), the words had not been presented in this order. Even though subjects had been instructed to recall the words in their original order, they apparently reorganized the lists into thematic word clusters and then recited them one after another during the recall test. In short, if the material to be learned lends itself to hierarchical grouping into categories and subcategories, then recall is grealy improved. For instance, a list which can be organized into categories and subcategories of food and tools, and then subdivided into subcategoris such a vegetables and meat, and gardening tools and carpentry tools, is much easier to learn than a list of unrelated items.

There is also evidence to suggest that category clustering is not merely an experimentally induced phenomenon or a strategy adopted in the artificial situation of laboratory setting. Morton and Byrne (1975), who recorded housewives' responses when they were asked to list the items required to equip a house, found their responses were systematically grouped either by category (furniture, linen, china, etc.) or by location (bedroom, kitchen, washroom, etc.). When they were asked to recall ingredients for recipes, these were clustered according to the temporal ordering of handling. Thus, for any material, more than one classification scheme is usually possible.

2.4.1.2 Subjective organization

Bousfield's method for studying thematic clusters has often been used in immediate-recall experiments. His technique, however, provided only a crude estimate of the degree of organization that is operative for any particular person on a given memory task. Given a list of names of various animals, people, automobiles and professions, one subject might organize this material into two main clusters: living versus non-living things; someone else might establish a more idiosyncratic categorization based on items that he/she liked versus those he/she disliked.

Clearly, we tend to remember by using the organization that is already inherent in the material. But assume that a list of words does not have any apparent organizational structure. Will people create their own organizational structures, and will these structures aid their recall performance?

Experiments by Tulving (1962) suggest that effective learners do indeed impose their own organizational structure on lists of unrelated items. This pheonomenon, called *subjective organization*, is consistent with the Gestalt outlook that learning is a process of activity imposing structure upon incoming stimuli. To test the idea, Tulving needed a way to measure the degree of subjective organization that each person employed. Because the organization was subjective and could vary from person to person, an experimenter would have no way to measure it from only recall trial. Therefore, in order to measure subjective organization, Tulving gave people a number of presentations of a list of words, presenting the words in a different order on each trial. He also asked them to recall the words after each trial. If participants were forming subjectively organized structures, one would expect to see a consistency in the order in which they recalled information across a series of trials. For example, if a person formed a subjectively organized structure from the words *tree*, *dog*, and *car*, one would expect these words to be recalled together on a number of recall trials. This type of internal consistency constituted Tulving's measure of the degree of subjective organization and the absolute number of words recalled. Tulving found that people with higher scores on the subjective organization measure also recalled a greater number of words. This led Tulving to believe that organization is responsible for improved recall and that organization of information occurs at input. The fact there is clearly a relationship between the number of words recalled and the measure of subjective organization, this study did not establish which, if either, was the cause or the effect. Thus, other ways of validating Tulving's claim were necessary.

A series of experiments by Mandler and Pearlstone (1966), and Mandler (1967) validated Tulving's findings;

namely, that memory is heavily dependent upon our ability to organize (or categorize) the material that we wish to retain. These studies showed that the larger the number of categories into which the subjects had sorted the words, the more words they remembered. Mandler (1967) suggests that in memorizing a list of words, we will often be more successful if we organize the elements of the task into a limited number of categories, making certain that no category is "overloaded". During recall, he hypothesized, we take advantage of this structure by first remembering the general categories that we have established and then reciting the individual words within these categories. This hierarchical arrangement can presumably be extended for several levels (or layers). That is, such organized packaging can probably proceed still further when a hierarchy of categories is used so that higher order categories (e.g., animal) contain subordinate ones (e.g., mammal), and so on down to the lowest level in the memorial hierarchy (e.g., raccoon). At least in principle, we ought to be able to memorize a virtually endless list of items by appropriate hierarchical schemes of this sort. However, Mandler believes that most people can keep track of only limited number of categories (five, perhaps) at any given level.

2.4.2 Organization and Structure in Memory Research

The study of semantic memory is concerned with the knowledge of the lexicon (human knowledge of words) and how to utilize that information to understand semantic relations (Tulving, 1972). In other words, semantic memory includes all the organized knowledge a person has gained through understanding the meaning of words and other symbols and their relationships, as well as ways of doing things. Recent efforts have focused heavily on the relation between classes of objects named by words, relations involving hierarchies (superordinate, etc.) and features. Two major aspects of the structure of concepts in semantic memory have been examined. First, how are concepts organized and connected to each other, and second, what processes are brought to bear in the course of performing particular tasks involving the information contained in semantic memory?

Even though a great number and variety of models of semantic processing have been proposed (for a detailed review see Smith, 1978), these models may be broken down into two classes. The largest class falls under the heading of *network models* (Anderson & Bower, 1973; Collins & Loftus, 1975; Collins & Quillians, 1969). In general, these theories resemble linguistic approaches to semantics in that concepts are defined in terms of their relationship to other abstract descriptions, rather like words or propositional statements. Network models are basically associationist in nature, with the distinction that the links between memory representations are not considered as consisting of simple strength bonds. Rather, these models assume that all concepts which correspond to lexical items are connected to one another by various sorts of pathways. The more links two nodes share the more similar they must be in meaning (Collins & Loftus, 1975; Collins & Quillian, 1969). Hence, the whole network resembles a dictionary in which words are defined in terms of other words elsewhere in the dictionary.

A second class of semantic memory models, the *set-theoretic models*, assume that the meaning of lexical items is represented by sets (Meyers, 1970) or features (Rips, Shoben, & Smith, 1973; Smith, Rips, & Shoben, 1974) or attributes. The sets or features summarize information about various categories which exist in memory (e.g., birds, foods, trees, etc.) by including information about category membership and the attributes, features, or properties of a category (e.g., fish, scales, fins, can swim, etc.). An individual can determine if two lexical items are similar in meaning by comparing all of their features or attributes. The more features or attributes they share the more similar their meaning is. A full discussion of the various models of semantic processing is beyond the scope of this review. For our purposes, it will suffice to examine an instance from each respective class, the Collins and Quillian (1969) hierarchical network model representative of the network theories and the Smith et al. (1974) feature comparison model representative of the set-theoretic theories.

2.4.2.1 Hierarchical network model

One of the first popular network models was proposed by Collins and Quillian (1969). According to this view, it is supposed that our knowledge is highly organized and interrelated (i.e., a vast network of concepts are interrelated to one another through a set of links or associations) and that the meaning of a word and indeed abstract concepts in general, is stored hierarchically in a semantic network. Factual information is made up of three types of structures: units, properties, and pointers. The first two are places or "nodes", in the semantic network that correspond to information about concepts. The third, pointers, are directional connections between the first two. The difference between units and properties lies in the kind of concepts they represent. A unit is a structure that corresponds to an object, event or idea: things that in English would be replaced by nouns or noun phrases, or if sufficiently complex, even sentences (e.g., *dog*, *sister*, *beautiful weather*). In constrast, a property is a structure that tells about a unit: in English grammar it would correspond to the predicate of a sentence or an adjective or adverb and so on (e.g., *solid*, *quickly*, *love*, *flowers*). Units and properties are more abstract structures than words. They are the semantic entries that correspond to these words, not the words themselves.

One of the chief characteristics of the hierarchical representation is that properties are stored in a very economical way. Each property is represented only once, at the highest level. Even though canaries, ostriches, and salmon all breathe, the *breathes* attribute is stored at the most inclusive level possible, namely, the level of *animal*. This approach was crucial for Collins and Quillian, who embodied their model in a computer program designed to comprehend simple statements. Because their computer had a limited storage capacity, they tried to conserve space by representing each property in the network only once. The assumption that each property is stored only at the highest possible level is called the *cognitive economy* assumption.

In addition to specifying some of the structure of the information involved in semantic memory, this model makes predictions about how people go about comprehending and verifying simple sentences. Collins and Quillian set about gathering evidence in support of their theory by giving subjects the task of verifying whether certain sentences were true or false. The speed with which the sentence could be verified was taken to reflect the nature of the search in semantic memory. If a feature is stored with the concept in question, it should be verified faster than if the feature is only stored at some higher level. These expectations were comfirmed with the reaction times of subjects to sentences. Sentences involving features presumed to be directly attached to the concept were verified faster than those involving features attached to an immediate superordinate which, in turn, were verified faster than those attached to a higher superordinate.

The hierarchical network model is important in that it provides an account of how we verify simple sentences and attempts to specify the structure of our semantic and conceptual knowledge. Nevertheless, the model has several problems. There are alternative accounts of the observations it is intended to explain (Conrad, 1972; Landauer & Meyer, 1972; Smith et al., 1974). Conrad (1972), in her empirical research, for example, has strongly criticized the notion of cognitive economy. Her research showed that variation in supposed hierarchical distance had no effect if familiarity was constant, but variations in familiarity had a substantial effect. The difference between sentences such as "A canary is yellow" and "A canary breathes", according to Conrad, is due to familiarity. "A canary is yellow" is more familiar linking of concepts than "A canary breathes". Conrad concluded that features are stored with every concept to which they are conceptually linked and that inferential processes do not generally occur in verification tasks. But it seems plausible to argue that features must sometims be found by inference, e.g., "William Shakespeare had a belly button" or "An osprey lays eggs".

Another observation not readily accounted for by the hierarchical network model concerns typicality (also called prototypicality) effects. Typicality refers to how good an example of its superordinate category a concept seems to be. Some members of a category are judged to be more typical than other members. For example, *robin* and *chicken* both belong to the category *bird*, but *robin* is judged to be a more typical bird than a *chicken*. In determining whether instances belong to a category, subjects respond faster to typical instances than to atypical ones (Rosch, 1973). The fact that subjects verify "A robin is a bird" faster than "A chicken is a bird" (Smith, 1967; Wilkins, 1971) should not happen according to the hierarchical network model, for the same distance in the hierarchy presumably has to be transversed in both instances (see Collins & Loftus, 1975).

The preceding problems have led to the revision of the model described above. Like its predecesor, the spreading-activation model proposed by Collins and Loftus (1975), also describes the kinds of processes that take place in a variety of semantic memory tasks studied by psychologists. In some ways, it is an extension of the hierarchical network model, though it is certainly more sophisticated, and has substantial advantages over that model. For one thing, the memory network is no longer structured hierarchically. Instead, it is structured around the principle of semantic relatedness or semantic distance. As before, many of the concepts are interconnected. When a cognitive unit in semantic memory is activated, this activation spreads along all of the paths or relations connecting this unit with other units. The more closely related two concepts are, the more links there are between them. The path between two concepts is short if they are closely related with regard to a particular property; the less closely related two concepts are, the longer the path is between them. The problem of typicality effect is also resolved; different birds will be highly inter-linked (particularly the more typical birds such as robins, sparrows, and wrens). The final assumption relevant here is that a particular amount of activation is required for making a decision, and the threshold level of activation at one point can be reached through the summation of spreading from related points.

Conrad's (1972) results are easily dealt with this model. High-frequency properties produce more rapid reactions because the properties are, in fact, stored directly at the queried node. Or, in network terms, there is a direct link between the particular node and the features. For example, *eagle* will be directly connected with *can fly* though it is, as well, connected directly to the superordinate *bird*. It is perhaps less likely that certain lower frequency features, such as *lays eggs* are directly linked to the subordinates, such as *eagle*. Hence, these and other results involving reaction time of judgements can be accounted for by this model.

In general, network models have provided useful frameworks for conceptualizing human knowledge. We often think of words as being separate psychological entities whose meanings are independent of other words. As network models suggest, however, the meaning of a word depends in large part on the relationships between that word and the many concepts in memory with which it is associated. We tend to define words in terms of other words and concepts, much as a dictionary does. We might single out one or a few attributes that define a particular word. But as we have seen, not all members of a category have attributes in common. Furthermore, we know much more about a word than the attributes that we often use to define it. Network models readily accommodate these aspects of meaning. The meaning of a word is given by the many concepts that the word relates to including the concepts that constitute our general knowledge of the world.

2.4.2.2 Feature comparison model

Although network models are currently the most numerous, there are other ways of representing information in semantic memory. One of the most elaborate set-theoretic models is the feature comparison model created by Smith, Shoben, and Rips (1974). In constrast to the network models described above, the feature comparison model proposed by Smith et al. represents words in semantic memory as a set of features or attributes. The semantic features are assumed to vary along a continuum of "definingness" (Smith, 1978). At one end of this dimension are the features, called *defining features*, that are essential for defining a word. At the other end of the dimension are *characteristic features*, that are characteristic of the concept but not essential for it. For instance, the word *bird* has the defining features *animate* and *has feathers*. These features are essential, or necessary and sufficient for defining the concept. *Birds* also have characteristic features such as *can sing* or *can be eaten by cats*. The latter features are of practical importance and characteristic of many birds, but they are not essential for defining the word. After all, many birds cannot sing, and a bird is a bird, regardless of what preys on it.

The model asserts that verifying statements such as *A robin is a bird* occurs by comparing the features of *robin* and *bird*. The model includes two stages. In the first stage of processing, the overall featural similarity of the two nouns is compared. This comparison includes both the defining and the characteristic features. If the featural similarity is very high, as it is in the comparison of *robin* and *bird*, then the subject rapidly responds *true*. Similarly, if the featural similarity is very low, as in the comparison of *robin* and *car*, then the subject rapidly responds *false*. The model includes decision processes that set the criterial that define high and low featural similarity and that determine whether the overall level of similarity is very high or very low.

In many instances, two nouns will be neither very high or very low in featural similarity. If the first stage has determined that there is an intermediate level of similarity between the two nouns, then the second stage is begun. In this stage, only the defining features of the two nouns are compared. If all of the defining features match exactly, then the subject responds *true*. But if any of the defining features of one noun do not match those of the other noun, the subject responds *false*.

The distinction between defining and characteristic features not only plays a role in deciding about category membership, but is also relevant to certain other phenomena including the typicality effect and the use of hedges. Note that it is the characteristic features that are essential for the occurrence of typicality effects. The model proposes that all or most members of a category have the same defining features, so the difference between *robin* and *chicken* is that *robin* includes many of the features that are characteristic of *bird*, whereas *chicken* does not. In this account, *A robin is a bird* is verified quickly because of the extensive overlap in the characteristic features of *robin* and *bird*.

The model is also consistent with the way people use linguistic hedges in everyday situations (Lakoff, 1972). Porpoises have many of the features that are characteristic of fish. As a result, many would agree with this statement: *Loosely speaking, a porpoise is a fish*. But *porpoise* and *fish* do not have the same defining features, so we tend to reject the hedgeless statement *A porpoise is a fish*. In a similar way, the model clarifies how we use hedges such as *technically speaking*, as in *Technically speaking, a whale is* *a mammal*. A whale is a mammal in that *whale* has the defining features of mammal (e.g., whales nourish their offspring by milk secreted by mammary glands). But whales are atypical mammals in that they lack characteristic features such as *has hair* and *lives on land*. It is the presence of defining features and the absence of the characteristic features that leads to the use of the hedge *technically speaking*.

From the above discussion it may be seen that the feature comparison model can adequately account for typicality effects and for other types of semantic memory phenomena. The model, however, is not without its difficulties. The distinction between defining and characteristic features is a troublesome one. This distinction is crucial, since the model uses characteristic features to account for typicality effects. It also states that the defining features provide the basis for comparisons during stage two. Unfortunately, the model does not include rules that stipulate which features are defining and which are characteristic. This limits our ability to specify how people make semantic comparisons. Moreover, most people have difficulty deciding whether any particular feature you can name is a defining or a characteristic feature of some concept. Is "having a cover" a defining feature of books? If a cover was ripped off would you call it a book? Such concerns raise questions about the desirability of basing a semantic memory model on such a distinction.

Other researchers, such as Rosch (1973; 1975) and her colleagues (Rosch & Mervis, 1975; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976), and McCloskey and Glucksberg (1979) have done away entirely with the notion of defining features (i.e., properties an object must have to be a member of a category). They assume, as did Wittgenstein (1953), that category members bear a "family resemblance" to one another. Rosch's analysis goes further than that of Wittgenstein since she argues that all of the members of a given category are not equally good members of the category. Members of a language category are assumed to have similar features, but with some members of the category overlapping on some features and others overlapping on other features. For the category as a whole, some features will be more representative of the category than others, but no feature that can serve to distinguish category members from non-members will be common to all category members within this framework. The typicality of an exemplar is determined by the number of characteristic features it possesses. The more attributes an item has in common with other category members, the higher the judged typicality of that item will be. Highly typical items share many attributes with other members of the same category, but share few attributes with members of different categories (Rosch & Mervis, 1976). A category such as fruit coheres as a category not because each member share any defining features of fruit, but simply because each member shares a "family resemblance" with the other members of the category. The greater the resemblance, the more central it is to the category.

Rosch and her colleagues conclude from their findings that categories do not have defining features but are instead organized in terms of family resemblance, with typicality of a category member determined by its feature overlap with other members of the category. However, it could be objected that asking subjects to list attributes biases them toward listing characteristic features of the category members. If subjects were indeed listing most characteristic features, then the correlations of typicalities and computed family resemblance scores could also be predicted on the basis of the Smith et al. feature comparison model.

In the end, the Smith et al. and Rosch views on category names come down to much the same thing. The semantic procedure for *bird* tests for the features of the prototype bird. It requires that some but not all those features be present. If a category has defining features, they must be present. But if a category is without many defining features, merely a sufficient number must be present for a close family resemblance. The more features an object shares with the category prototype, the more central it is to that category.

Perhaps the most serious question to be asked is whether meanings can be described adequately by semantic features. Even if most words can be decomposed logically into a set of features, that does not mean that people actually use those features in performing semantic tasks. For example, *robin* can be decomposed logically into numerous features. But do people really decompose that word in order to understand its meaning? In processing a concept such as *robin* people may not break the prototype down into its component features.

2.5 Issues in Aphasic Research

> T'was brillig, and the slithy toves
> did gyre and gimble in the wabe.
> All mimsy were the borogoves,
> and the mome raths outgrabe.

When confronted with this delightful piece of nonsense in her Looking Glass Adventure, Alice seemed to speak for all aphasics when she commented, "somehow it seems to fill my head with ideas--only I don't know exactly what they are!"

It is interesting and somewhat ironic that until recently, advancement in our understanding of language functions in the brain has come not from the study of normal individuals but largely from the study of individuals with injured brains. Whenever disease or injury affects the left side of the brain, some aspect of the ability to perceive, process, or produce language may be disturbed. Individuals with such brain disturbances can give us insight into how the brain carries out its language-related tasks.

During the last two decades, there has been a surge in the number of neurolinguistic studies of aphasic patients. The rationale for these studies has been to determine the independent components of language structure and language behavior by analysis of the abilities of aphasic patients. By studying which aspects of language can be selectively impaired following brain damage, it was hoped that the structure of language and its relationship to brain organization could be determined. However, one must be cautious when attempting to draw conclusions from data obtained only with brain-damaged individuals since it is not always clear how much the damage itself confounds the functioning of intact parts of the brain.

Nevertheless, the evidence from aphasia should provide a growing body of information about such matters as the storage of linguistic information, the localization of linguistic function, the interrelationships of the various functions, and possibly even the reality of the language systems that linguists postulate. The aim of this section of the review is to survey the semantically oriented research on language behavior following brain damage, in particular that related to the nature and organization of the subjective lexicon under conditions of brain damage.

2.5.1 Current Controversies in Aphasia

For over a century scholars have debated the question of speech and language localization within the brain. After several centuries of debate, two different views of the brain's functioning in language production have emerged, namely, the localizationists and the generalists. The former think of aphasia as resulting from the malfunction of specific areas of the brain. The latter, while acknowledging the brain's areas of specialization, consider that aphasia affects the entire brain and is not limited to any specific locales, however they might be damaged.

Probably the strongest recent advocates of a general underlying language ability affected by brain damage are Schuell and Jenkins (1964; see also Schuell, Jenkins, & Jimenez-Pabon, 1964). On the basis of extensive standardized testing with a large sample of aphasics, they claim that there is a central language deficit that appears in all aphasics. Although Schuell and Jenkins have suggested that there are probably specific phonemic, semantic, and syntactic characteristics involved in aphasia, they argue that these characteristics are relatively consistent across all modalities: "The observed communication deficit is not modality specific and exhibits a rather impressive regularity of symptomatic errors. This regularity is shown both in the kinds of errors that occur and in the level of impairment observed" (Jenkins, Jimenez-Pabon, Shaw, & Sefer, 1975, p. 101). However, what varies between aphasics is the severity of the impairment of the language ability and also the extent to which other functions not specifically linguistic are impaired.

The Boston Veterans Administration Hospital group (e.g., Goodglass, Geschwind, Benson, Kaplan, and Sparks), on the other hand, have used a broadly inclusive definition of aphasia embracing impairment which other aphasiologists have considered to be separate from aphasia (e.g., agnosia, apraxia). The Boston group have found it useful to make a distinction among aphasias on the basis of type of speech pattern, designating aphasics as fluent and non-fluent. Fluent aphasias encompass Wernicke's and conduction aphasia and what has been called anomic aphasia, whereas non-fluent aphasia is primarily Broca's aphasia.

What perhaps most deeply divides the thinking of the Boston group from a researcher like Schuell, is the view that aphasia may impair specific language modalities while leaving others intact. Goodglass and his associates have, for example, called attention to such modality-specific cases as a naming difficulty in which patients may be able to recognize an object by touch, but cannot name it until they see it (Goodglass, Barton, & Kaplan, 1968). No doubt these observations are in conflict with the findings of Schuell and other investigators who have concluded that aphasia affects all language modalities and does so about equally. Various writers have pointed out that Schuell and others have tended to study aphasic patients with relatively large areas of brain damage and severe communication disorders, these being the patients who are generally seen for treatment. On the other hand, the Boston group, in order to demonstrate the range of phenomena of aphasia have frequently focused their attention on milder cases with injuries that are probably smaller or localized at the periphery of the language areas. However, those who maintain an unidimensional view of aphasia counter this claim with the assertion that modality-specific communication difficulties exhibited by some aphasic patients are not aphasic, but are rather examples of agnosia or apraxia, which may or may not be accompanied by aphasia.

2.5.2 Classification Systems of Aphasia

Despite the long history of controversy and a proliferation of confusing terminologies, one fact on which there is considerable agreement is that the brain's left hemisphere is more intimately involved in language than the right hemisphere. Since Broca's time (1865), it has been apparent that damage to the left hemisphere is far more likely to result in aphasia than is corresponding damage to the right hemisphere. Broca's observation that aphasia is associated with left hemisphere damage was the first indication that language functions might be localized in particular areas of the brain. However, Wernicke (1874) was the person most responsible for initiating the modern study of this field. He established clearly the fact that there were linguistic differences between the aphasias produced by damage in the left temporal lobe, in what is now called Wernicke's area and those produced by lesions in the frontal lobe in Broca's area.

Since the time of Wernicke, researchers have attempted to describe different types of aphasia by identifying clusters of symptoms associated with particular brain lesions. This has proven to be a difficult task, particularly because so few cases are thoroughly studied and partially because so few well-studied cases ever come to autopsy. (Recent diagnostic tools such as computer axial tomography (CAT) scans and research techniques like regional cerebral blood flow mapping are beginning to alter this picture.) Therefore, a debate has festered over which lesion produce which cluster of aphasic symptoms. Many authors have considered different types of aphasia to be totally independent of one another, but there is no convincing proof of this claim.

It is generally difficult to pinpoint the locus or extent of brain damage. But even if we know where the damage has occurred and what brain structures have been affected by it, we may be still hard pressed to related the damage to the resulting language behaviour symptoms. After all, as Lenneberg (1975) so aptly points out, the brain's structures are very complexly interrelated, with the results that damage to one structure is likely to produce changes in the functioning not only of that structure but of many others as well.

The classifications of aphasia are almost as numerous as the researchers attempting to make them. A review of classification systems for the aphasias reveals considerable variation in the types and terminologies proposed. Most proposed syndromes carry with them a certain degree of anatomical predictability which, though far from perfect, allows clinicians to infer location and prognosis. By focusing on clusters of symptoms (a syndrome) for each variety of aphasia in a given classification and by noting, when available, the suggested location of pathology, obvious correlations between the various classifications can be seen. In consideration of a specific aphasia patient, at the same time, the time post-onset and the etiology of the disturbance must be taken into account. Finally, the effects of age and inherited and acquired premorbid individual differences in cerebral organization, particularly lateralization of function, interact with lesion variables to produce in each patient a unique combination of language, emotional, and cognitive assets and liabilities, regardless of the specific syndrome subtype into which he or she falls.

Notwithstanding the many individual differences, most classification systems have dichotomized the linguistic behaviors demonstrated by aphasic persons into broad types of disorders of input-output, such as sensory-motor, receptive-expressive, decoding-encoding and comprehension-production. To date, no consistent classification system, or for that matter definition, of aphasia has been established. Terminological confusion persists, due, in part, to the multidisciplinary interest in the subject (e.g., clinical, physiological, and behavioural), but also due to the diversity of philosophical and psychological theories on which much of the work has been based. The two major types of aphasia have received a variety of different names. For the first type these include:

1. *Anterior aphasia*, after the location of the lesion that causes it.
2. *Broca's aphasia*, after the French physician Paul Broca, who first described its symptoms and localized the lesion area primarily associated with it.
3. *Expressive* or *non-fluent aphasia*, after its most obvious symptoms, halting, laboured, and tortuously articulated speech.

This type of aphasia is associated with certain kinds of expressive and motor difficulties which affect the ability to speak. There is a loss of articulation and grammatical skills but not notably of vocabulary and comprehension skills. Relative to their expressive disorder, these patients exhibit good auditory comprehension of single words although they have marked difficulties decoding complex syntactic structures. Small words such as prepositions, articles, pronouns, and conjunctions are omitted so that speech takes on a telegraphic quality. It is the phonemic and syntactic aspects of linguistic processing that are most affected, while semantic and communicative intent of language is largely preserved. This type of aphasia has also been termed verbal aphasia (Head, 1926), efferent motor aphasia (Luria, 1964), and syntactic aphasia (Wepman & Jones, 1964).

The second type of aphasia has been called:

1. *Posterior aphasia*, after the location of the lesion that causes it.
2. *Wernicke's aphasia*, after the German physician Carl Wernicke, who first described and localized it.
3. *Receptive* or *fluent aphasia*, after its two most obvious symptoms, a lack of comprehension and fluent production of meaningless sentences.

The primary characteristic of this type of aphasia is impairment in the ability to understand spoken and written language, even though hearing is normal. Fluency is usually not a problem, but interruptions in the flow of speech occur when the patient cannot retrieve a specific word. The speech of such a patient is termed "empty speech" when it lacks clear content and direction; in most severe cases, speech consists almost entirely of neologistic jargon.

These patients' difficulties in auditory comprehension are more severe than their expressive disorders. They are usually unaware of their errors during the early post-onset period, making treatment difficult until they become aware of their difficulties and begin to inhibit their output.

Aphasiologists speculate that Wernicke's aphasics have damaged feedback systems, limiting their ability to monitor what they say and thus limiting their ability to correct themselves. This aphasia type has also been called semantic aphasia (Head, 1926), acoustic aphasia (Luria, 1964), and pragmatic aphasia (Wepman & Jones, 1964).

Another of the fluent aphasias is anomic aphasia, the hardest syndrome to localize neuroanatomically. Anomic aphasia patients' otherwise fluent and well-formed speech is marred by word-finding difficulties. The patient has no other obvious difficulty in his or her spontaneous speech (i.e., relatively little expressive or receptive difficulty), although speech flow may be constantly interrupted because of the patients difficulties with word retrieval. These patients are usually aware of their word-finding difficulties, although they do not know when they have retrieved the correct word and thus continue their searching behavior. Word retrieval problems that typify anomic aphasia are common to all aphasias, but only in these patients do they contribute the salient symptom. Word retrieval problems generally allow speculation about the role of memory in the generation of aphasic problems. While aphasia can hardly be explained as a language-specific memory loss, memory certainly plays a role in aphasia, and short-term memory difficulties can often co-exist with it. Other terms used for this syndrome include nominal aphasia (Head, 1926), semantic aphasia (Luria, 1964; Wepman & Jones, 1964), and amnesic aphasia (Goldstein, 1948; Weisenberg & McBride, 1935).

It is not unusual for the aphasia-producing lesion to encompass both the anterior and posterior speech areas. The result is likely to be a mixed or global aphasia.[2] As the name suggests, this syndrome describes the condition in which virtually all language functions are severely impaired.

2.5.3 Current Research on Semantic Relations in Aphasic Patients

While the structure of the subjective lexicon in normal language speakers has been studied extensively (Berlin & Kay, 1969; Fillenbaum & Rapoport, 1971; Lehrer, 1974; Miller, 1972; Miller & Johnson-Laird, 1976; Rosch, 1975), only recently (in particular the last decade), have attempts been made to assess the status of lexical knowledge in aphasia (Goodglass & Baker, 1976; Grossman, 1978, 1981; Zurif, Caramazza, Myerson, & Galvin, 1974). By far the most extensively investigated lexical capacity in aphasia concerns the ability to name objects on confrontation. As Lesser (1978) has rightly pointed out, it is not an ability that is typical of normal language use and it is probably not a very good index of a patient's overall lexical knowledge. Needless to say, it is an ability that is often impaired in aphasia, and as such, has received considerable attention. Variables or parameters such as frequency with which words appear in the language (Howes, 1964; Wepman, Beck, Jones, & Van Pelt, 1956); word associations (Howes, 1967; Rinnert & Whitaker, 1973); broad semantic categories (Goodglass, Klein, Carey, & Jones, 1966; Whitehouse, Caramazza, & Zurif, 1978); and the internal structure of various semantic domains based on semantic features (Epstein, 1975; Zurif et al., 1974) have all been implicated to varying degrees, in naming disruption. Even nonlinguistic factors such as the picturability of an object to be named (Goodglass, Hyde, & Blumstein, 1969) and the sensory-motor schema involved in the knowledge of a word's referent (Gardner, 1973) have been examined.

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[2] The distinction between mixed and global aphasias is a practical one, typically made on the basis of the severity of the presenting problem. Mixed aphasia usually refers to patients whose problems involve both comprehension and production, but are less severe; global aphasics are the more severely impaired.

2.5.3.1 Word frequency

How important is word frequency in the aphasic patient's ability to understand words? What kind of words cause difficulty to aphasics? Are the difficulties of aphasics in word usage similar to those of other types of speakers? Among the studies which have investigated the effect of word frequency on naming in aphasics are those by Fillenbaum, Jones, and Wepman (1961), Goodglass, Hyde, and Blumstein (1969), Howes (1964), Rochford and Williams (1962; 1965) and Wepman , Beck, Jones, and Van Pelt (1956).

Wepman et al. (1956) compared spontaneous speech of an anomic patients (usually associated with posterior damage) and a normal subject. After examining the word frequency distribution of the anomic patient, these researchers felt that this disorder was not related to part-of-speech category at all. Rather, they found that anomic speech is characterized by an over-representation or over-use of high-frequency words of all form classes (i.e., all grammatical categories). A close examination of their data indicates that this disproportionate use of highly frequent words was most marked for nouns, and that the aphasic's speech was especially deficient in low-frequency words. The nouns that were retained were very general words such as *thing* and *people*, but more specific nouns were lacking. This was generally true also for verbs and adjectives in that very general and common verbs (*do*, *like*, *has*) and adjectives (*good*, *nice*, *wonderful*) were used excessively, but more specific words were omitted. In discussing their findings, the authors suggest that the fundamental problem of anomia is over-dependence on high frequency words, rather than name finding difficulty as such. They speculate that the anomic aphasic patient has lost "voluntary control of those relatively infrequent words" (with high information content) and has retained "automatic use of the highly infrequent" (pp. 476-477), or over-learned words and word combinations, which normally qualify more informative words.

The frequency of use of different lexical categories in spontaneous speech has also by examined by Fillenbaum, Jones, and Wepman (1961). They found that the frequency of occurrence of words of different form classes (e.g., nouns, verbs, adjectives, prepositions, and conjunctions) in the free speech of aphasics could differentiate among two groups of aphasics and a group of normal control subjects. The two groups of aphasics were labeled syntactic aphasics (Broca's), with a reduction of high-frequency words in closed grammatical classes such as function words, and semantic aphasics (Wernicke's), with a reduction of low-frequency words in open lexical classes such as nouns and verbs. Hence, the frequency of occurrence of words of different form classes was found to differentiate between these two aphasic groups.

Rochford and Williams (1965) undertook a series of studies to examine the relationship between frequency of word usage and ease of naming using the Thorndike-Lorge word count (1944). Within the same semantic category (body parts) and with the same visual contact (the experimenter's own body) the word frequency effect was as strong as it was with a heterogeneous set of pictured words. Despite the same semantic and visual conditions, a marked effect of frequency obtained. They also examined what occurred when aphasic subjects were asked to name composite words which were made up of two words of unequal frequency such as *sun-dial*. They devised a list of composite words in which either both of the composite words were common or one of the words was rare, and found that the patients' difficulties in naming were related to the frequency of the first word in the combined pair. Word combinations which were common-common (*penknife*, *lighthouse*) or were common-rare (*wheel-barrow*, *hedge-hog*) were easier than word combinations which were rare-common (*padlock*, *spinning wheel*). Homonyms were also tested to see whether their commoner or rarer meaning was named more easily. All the subjects named the common objects more easily. Rochford and Williams summarized their findings by saying that high frequency of usage was the main factor responsible for the easy accessibility of words:

> ...availability of words is a function not only of their overall frequency of usage but also of the frequency of their parts, the initial syllable providing a cue which increases the response probability expected from the frequency of the whole word. (1965, p. 381)

Goodglass, Hyde, and Blumstein (1969) found that Broca's and fluent (Wernicke's and amnesic) aphasics did indeed differ in the proportion of picturable to non-picturable nouns used but only in the high-frequency range. Fluent aphasics use many more non-picturable and abstract words that occur idiomatically but without much informational value than Broca's aphasics, in their free-flowing speech. Many of them are words which occur repeatedly in a variety of the every-day expressions with which the fluent aphasics fill in their conversation (e.g., *year*, *time*, *day*, *work*, *minute*). Broca's aphasics have an equal over-use of frequent nouns, but these include more words of specific concrete reference.

In another study, Rochford and Williams (1962) also tested whether or not aphasic misnamings could be related to the age at which children learned the words. More specifically, they investigated the breakdown of the use of names by adult aphasics and by normal adults under stress, and the acquisition sequence of children ranging in ages from 2 to 12. The 32 aphasic subjects varied in the degree and nature of their language impairment. The subject's task was to name three common objects, *comb*, *watch*, and *basket* and four of their parts, *handle*, *hands*, *teeth*, and *buckle*, from pictures.

In terms of proportion correct and number of cues required, the order of difficulty of these seven names was given. That is, *comb* was the easiest and *buckle* was the most difficult for all groups. There was a close parallel between the number of correct responses given by the aphasic adults to the word and the age at which children had learned the names. For instance, *comb* was acquired at age 2, *handle* at age 6 and *buckle* at age 11. It seems that the names first learned in childhood are names last lost in aphasia. Earlier learnt responses tend to be the most frequently used responses throughout life "because of their great communication value and high frequency of usage and this is the factor mainly responsible for their easy accessibility" (1965, p. 380). Consequently, Rochford and Williams report that "the similarities between the performances of children and dysphasic adults are so close that it almost seems possible to speak of 'naming age' in nominal dysphasia" (i.e., a loss of the ability to name objects) (1962, p. 227), although children and aphasic adults were helped to recall names by different kinds of cues. Normal speakers under stress, distraction, or confusion after electro-convulsive treatment showed similar naming difficulties and errors, and patterns of language breakdown to that seen in nominal aphasia.

2.5.3.2 Word associations

Word association research suggests that aphasics' lexical comprehension deficits are not related to a total breakdown in the mechanisms associated with linking words to other words (and similarly, concepts to other concepts). It has been pointed out by Schuell (1950; Schuell & Jenkins, 1961), and Rinnert and Whitaker (1973) that there is a considerable resemblance between the naming errors of aphasic patients and the associations given by normal subjects.

The beginning of word association research is generally accredited to Galton (1879) in the latter part of the 19th century (Forrest, 1977). The method of word association was first applied for psychodiagnostic purposes by Jung (1910) to detect the presence of neurotic conflicts. Clinical applications of the technique involve interspersing certain emotionally loaded words, or words of special significance to the examinee, among neutral words. Long response times or bizarre associations to words may be symptomatic of emotional disturbance. More recently, because these responses tend to show a predictable degree of agreement and provide an empirically more verifiable measure of semantic relations, this method has been used as a way of exploring the nature of the relationships within the lexicon.

It has been observed clinically that when aphasic patients are asked to point to objects or pictures named by the experimenter, they tend to confuse words which sound alike (e.g., *lake*, *rake*), an auditory perceptual confusion, and words associated in meaning or experience (e.g., *sky*, *blue*), a semantic confusion; and that only a few patients (i.e., those most severely impaired) confuse dissimilar unrelated words (Schuell, 1950). Schuell and Jenkins (1961) studied systematically the kinds of errors aphasics make in word identification. The experimenters asked an unselected sample of 117 aphasics to choose the picture of the item named by a test word from a multiple-choice picture array. For example, one of the pictures had the object referred to by the experimenter (*man*); one an object with a name that rhymed with *man* (*pan*); one an object closely associated with the test object (*woman*); and one an unrelated object (*star*). In principle, any of the latter three could as well be erroneously chosen as any other.

The subjects' actual errors were predominately associative. Errors of the rhyming type were much less frequent, and choices of the unrelated pictures were extremely rare. Most random errors were made by severely impaired aphasic patients and most associative errors by the least impaired aphasic patients. Only at the severe levels of vocabulary deficit do the associative processes themselves begin to breakdown. The same kinds of errors tended to appear whether the patients were asked to point to objects named by the experimenter, to name objects, to match words to pictures, to match spoken to printed words, or to write words in dictation. In short, Schuell and Jenkins observed that the erroneous naming responses of aphasic patients resemble the word associations of normal individuals.

A survey by Rinnert and Whitaker (1973) analyzed data from published literature sources taken from a variety of aphasic syndromes in different languages as well as personally studied case histories. The question raised was the semantic relationship between what a patient said or wrote (regardless of test format) and what the correct target word should have been. They used the following 11 categories in taxonomizing aphasic semantic confusions: synonyms, antonyms, coordinates from the same category (*coat-sweater*), sub- and superordinates (*vegetables-potatoes*; *banana-fruit*), object description (*water-wet*), part-whole relations (*children-family*), action-outcome (*speak-discussions*), spatial contiguity (*glasses-eyes*), item location (*chair-office*), instrument-function (*curtains-draw*), and shape and size analogies (*boy-small pencil*).

Analysis showed that aphasic semantic confusions could be compared in terms of features that the response and the target both shared and differed in. The shared features tended to represent major semantic categories, thus reinforcing intuitive notions of semantic fields, and the contrasting features tended to represent minor and/or highly specific functional distinctions.

When this and similar data were compared with published studies of associations by normal subjects, it was found that the two sets of data were remarkably alike, suggesting that both can provide insights into the semantic organization of the internal lexicon. If anything, the semantic confusions of aphasic patients are slightly more specific in terms of semantic features than the data obtained by the word association technique used on normal subjects. Furthermore, it seems to be the case that the semantic errors made by aphasics are not qualitiatively different from those made by normals when distracted, emotionally upset, fatigued, or otherwise disoriented or confused.

If the naming errors produced by aphasic patients are comparable to normal word associations and if both can be taken as an indication of how the internal lexicon is structured, then it is reasonable to think that language-impaired patients could themselves produce word associations that might provide information about semantic structure. A direct test of the extent to which normal associations are impaired in aphasia was reported by Howes (1967). Howes found that Type A aphasics (corresponding approximately to anterior or Broca's aphasics) display a normal pattern of word associations, although they produced associates with greater latency than do normals. The Type B aphasics (corresponding to anomics and Wernicke's aphasics), on the other hand, produced erratic associations bearing little resemblance to the normal data. Clearly, the patient class with the most severe word finding difficulties displayed a serious disruption of associational structure.

This finding was corroborated and extended by Lhermitte, Derouesne, and Lecours (1971), who presented word pairs that were "associated" or "unrelated" to aphasics for their judgements. Lhermitte et al. examined the breakdown of the associative network of words for French-speaking aphasic patients. Aphasic patients exhibiting various symptomology were presented two tasks that involved sorting cards containing printed words. In the first task, they were asked to classify 12 words according to whether they were closely related, remotely related, or not at all related to a key word. The choice was forced, in that they had to place four words in each of these three categories. There were ten items of this type. All the words to be sorted were nouns or infinitive forms of verbs. For example, the target word *fish* would be closely related to words such as *ocean* and *fisherman*, remotely related to the words *odour* and *cooking*, and unrelated to the words *chair* and *fantasy*. For the second task, the aphasic patients were given a key word, a homonym which had from two to four meanings. They had to select from seven words as many of these meanings they could; the choice in this case was therefore not forced. For example, the target word *division* had different senses that may be evoked by words *army* and *calculation* but has no sense that is related to the words *sky* and *couch*.

Patients' errors were categorized into three groups: severe disruption of the hierarchical relationships among the words (i.e., a tendency to confuse words belonging to the central and to peripheral part of the semantic field), "narrowing" of the field (i.e., tendency to exclude from the field words obviously associated with the target), and "broadening" of the field (i.e., tendency to include words having no obvious associative link with the target). Patients with all types of symptoms produced responses in these three categories, but patients with anterior damage were especially represented in the group of making hierarchical errors. Errors of this type indicate that category boundaries are somewhat ill-defined, but they do not represent gross errors of association. Patients with posterior damage, on the other hand, produced the most serious semantic structural violations by tending to broaden a semantic category to include unrelated associates, an impairment similar to that of Howe's Type B patients.

Goodglass and Baker (1976) attempted to record the associational structure among groups of words and to link that structure to the patients' naming ability. Stimulus words were eight high-frequency (*bottle*, *cake*, *disk*, *drum*, *glove*, *knife*, *orange*, and *sheep*) and eight low-frequency (*accordian*, *awning*, *cactus*, *crowbar*, *easel*, *flask*, *garter*, and *ostrich*) picturable nouns depicted on cards and presented visually for naming to groups of high-comprehension aphasics (presumably anterior damaged) and low-comprehension aphasics (presumably posterior damaged), and to two control groups (non-aphasic brain-damaged patients and non-neurologically impaired normal controls). After the naming data had been obtained, each picture was presented a second time, while subjects were instructed to squeeze a rubber bulb whenever one of a series of spoken words (a tape-recorded list of 14 words) "reminded" them of the presented target picture. Seven of these words bore a specific type of associative relationship to the target word, whereas the other seven functioned as unrelated distractors. The words included the name of picture item and a variety of asociations to the item: superordinates, attributes, coordinates, functional associates (the name of an action asssociated with the word), and functional context (the name of a situation or context in which the item could be found). Responses were analyzed in terms of both reaction time and error rate, which revealed similar patterns. It should be noted that false responses to unrelated words were quite rare.

With regard to semantic structure, the non-aphasic control subjects and those with high comprehension exhibited a similar pattern of associations. For all three of these groups, the clearest associates were the superordinate category name, the descriptive attribute, and terms related by situation or context (functional context). Other associates were also included in the semantic network of these groups, but responses to these items were markedly slower than responses to the three strongest associates.

In contrast to the other patients, the low-comprehension aphasics differed in their pattern of responding; they had great difficulty recognizing both functional contexts and functional associates as related to the target word. In other words, they had particular difficulty in identifying words that were functionally (e.g., *eat*) or contextually (e.g., *breakfast*) associated with the picture (e.g., an *orange*). On the basis of these results, Goodglass and Baker argued that the failure to recognize this type of semantic organization by low-comprehension patients (defined by the inability to retrieve words in a naming task) may be, in part, a function of breakdown of semantic structure. Though all patients recognized the names of the pictured objects equally well, many patients had not previously been able to produce them. All patients responded most quickly to associates of words they had been able to name and the low-comprehension patients were much less likely to respond to associates of words they had failed to name. Since the latter group had difficulty producing names for the pictures in a previous test, although they could recognize the names of the objects, Goodglass and Baker suggested that the ability to produce a name depends on arousing various kinds of information associated with the name, and when the posterior speech area is damaged, it is the associative (or semantic) structure that is disrupted.

2.5.3.3 Semantic features

The last two studies mentioned above (Goodglass & Baker, & Baker, 1976; Lhermitte et al. 1971) indicate some disruption of the relationship among lexical items in a semantic field. However, they do not make any assumptions about how the items within the field are related. On the basis of recent attempts to describe the organization of the lexicon in the normal language speaker in terms of a hierarchical arrangement of semantic features (Bierwisch, 1970; Miller, 1972), some researchers have tried to discover if aphasic subjects would also show a knowledge of word meaning based on the same hierarchical organization (Epstein, 1975; Grober, Perecman, Kellar, & Brown, 1980; Lhermittee, Lecours, & Bertaux, 1969; Zurif et al., 1974).

Semantic features are taken to represent the lexical information available to language users and to capture the concepts in a word, as well as define the range of semantic relations that a word can enter into with other words.

Lhermitte, Lecours, and Bertaux (1969) proposed an explanation of how semantic features were perceived by aphasic patients, based on the following observations. First, when responding to a stimulus, each semantic paraphasia made by the subject moved closer in terms of semantic features to the target word. For example, when the target word was a female tiger (*tigresse*), the subject first responded by identifying where the animals lived (*sous les tropiques*), then the target word was called a *jaguer*, followed by identifying it as a male (*tiger*), and then the subject finally reached the target word of *tigresse*. The above example was often verifed as the patient rehearsed aloud as he moved toward a target.

Secondly, a long latency period between the stimulus presentation and the response was frequently noted. This latency period seemed to suggest that the aphasic subject was "searching for" the appropriate combinations of semantic features. Therefore, it was suggested that not all semantic features were present in the aphasic's determining tendency at one moment in time. Rather, the subject must prime over time the semantic features needed to describe a word. These semantic features seemed to be grasped in a progression from the more general to the more specific. If Lhermitte et al. are correct in postulating that the aphasic orders and retrieves features from general to more specific, then what features are considered by the aphasic to be easier or harder to retrieve? This was the nature of research carried out by Zurif, Caramazza, Myerson, and Galvin (1974).

Zurif et al. (1974) examined the relationship between aphasia and lexical organization in a group of aphasic patients, some with anterior damage and some with posterior damage, relative to a normal control group. They speculated that if word comprehension and production were impaired, then a representation of semantic relations in memory would also be restricted or impaired. Further, they questioned whether distinctions between semantic representation systems would be found among different types of aphasics. In this study, both normal and aphasic patients were presented with triads of printed words (high-frequency concrete nouns), and asked to indicate which 2 or 3 words were most similar in meaning. This was done for all possible combinations of 12 words chosen to capture several different types of relationships among their semantic features. The 12 words included terms for human beings (*mother*, *wife*, *cook*, *partner*, *knight*, and *husband*) and animals (nonhuman) (*shark*, *trout*, *dog*, *tiger*, *turtle*, and *crocodile*). The subjects' similarity judgements (by group) were analyzed using both a hierarchical clustering technique and a non-metric multidimensional scaling program to extract structural organization that patients had imposed on the items.

The following results were obtained. The normal controls separated the words into human versus animal terms. The animal terms were then subdivided into three groups consisting respectively of fish, reptiles, and mammals: i.e., *shark* and *trout*, *crocodile* and *turtle*, and *tiger* and *dog*. The anterior aphasics also divided the words into human and animal terms, with the exception of the word *dog*, which was considered a member of the human category by these aphasics. Zurif et al. noted that *dog* may have been grouped with the human items based on the idea that, "a dog is a man's best friend" (p. 179). After making the basic human-nonhuman (animal) distinction, the anterior aphasics subdivided the animal terms in a different way from that of the normal control subjects. Put another way, they showed some degree of semantic impairment since they sorted the animal terms not on the basis of the feature "species membership" as the normal controls did, but on the basis of the feature of "ferocity", which is tied more to an emotive "residuum of meaning" (Miller, 1972) than to the more abstract feature "species membership". These patients generated two main clusters of animal terms that violated the species boundary, one consisting of "dangerous" animals (all ferocious, wild and remote), *shark*, *crocodile* and *tiger*, and the other consisting of "harmless" water animals (edible), *trout* and *turtle*. Caramazza & Berndt (1978) have suggested that anterior aphasics are relatively restricted in their range of conceptual integration.

> ...verbal concepts in anterior aphasics appear to be more tightly tied to affective and situational data...the normal adult has a number of levels at which he can organize his lexicon--some referentially practical, others linguistically practical--whereas the aphasic primarily retains these features of words that relate to perceived or imagined environmental situations. (1978, p. 909)

On the other hand, the posterior aphasics in the Zurif et al. study displayed even less ability to organize lexical items by semantic features. Despite the fact that they had been able to recognize a definition of the words on a pre-test, the posterior-damaged patients failed to make even a basic human-nonhuman (animal) distinction. They displayed near random performance when grouping nouns on the basis of their similarity in meaning. In fact, the only reflection of the human-nonhuman distinction the posterior aphasics showed was to cluster the human terms more compactly than the animal terms and this seemed to be because they could more easily fit the human items into copula sentences than they could the animal ones, choosing, for instance, to link the words *mother* and *cook* on the basis of "My mother is a good cook" (p. 181). In other words, the posterior aphasics inserted a verb as a "syntactic" carrier in order to choose the two nouns most similar in meaning. In the end, Zurif et al. conclude that their "data do indicate a relation between subjective lexical organization and word-finding difficulties in aphasia" (p. 185).

Considering how complicated language processing is, it is quite possible that the anterior aphasics' difficulties may stem from both retrieval failure and some degree of conceptual disorganization. But whatever the explanation for anterior aphasia, posterior aphasia most certainly includes a notable component of conceptual disorganization. In a related study, Epstein (1975), using both nouns (*father*, *mother*, husband, *wife*, *man*, and *lady*) and verbs (*walks*, *builds*, *washes*, *clean*) as stimuli, obtained comparable findings. Her results also showed that normal and anterior aphasic subjects grouped nouns and verbs similarly, but posterior aphasics grouped them dissimilarly.

2.5.3.4 Semantic categories

Semantic categories have been examined in aphasia to test the extent to which, if at all, they can be selectively disturbed. From the linguistic perspective the question is whether or not selective misnamings of one category can occur within classical anomia, indicating that within the neurological organization of the language there are specialized representations of categories which can therefore be disturbed selectively. Some researchers suggest that aphasia disturbs all semantic processing equally, and that the differences which are found in naming in some categories can be attributed to non-inherent differences like perceptual saliency or frequency (Schuell & Jenkins, 1961; Schuell et al., 1964). Others believe that the word-finding system in the brain can be subdivided anatomically according to the nature of different word categories (Goodglass, 1973; Goodglass, Klein, Carey, & Jones, 1966).

To date, only a few semantic categories have been given any special consideration in the study of aphasia. These include body parts, colours, alphabet letters, cardinal numbers, geometric shapes, kinship terms, professional roles, room objects and, as a very large category, "object names".

Goodglass and his associates (Goodglass, Klein, Carey, & Jones, 1966) have been among those to suggest that word comprehension in aphasia is a general phenomenon but related to the semantic categories of words. Goodglass et al. examined the order of difficulty of object names (e.g., *chair*, *glove*, *cactus*), body parts, actions (e.g., *smoking*, *sleeping*, *dripping*), colours (e.g., *blue*, *brown*, *purple*), numbers (e.g., *7*, *42*, *1963*), letters (e.g., *L*, *R*, *G*), and geometric shapes (e.g., *circle*, *triangle*, *star*) in a test in which the patient was asked either to name a visual stimulus or to choose the correct visual stimulus in response to the spoken name. Both comprehension and production were examined in letter names, number names, colours, actions and objects, but only comprehension for body parts and geometric shapes. The material used for the objects and actions consisted of black and white line drawings. In studying the differences in comprehension and naming of words in these categories, Goodglass et al. found that orders of difficulty were different in the two modalities.

The categories differed, as was expected, in their degree of difficulty due to the number of class members per category and their distinctiveness. The fluent aphasic patients were markedly deficient in object naming and markedly superior in letter naming relative to their performance on other categories, although the absolute level of object naming was virtually the same for the Broca's and fluent aphasics. In contrast, Broca's aphasics, tended to find object naming easier than letter naming. Comprehension, thus measured, did not distinguish among types of aphasics, while name production clearly did and comprehension and production resulted in different overall orders of difficulty. Object names, the easiest to comprehend, were the hardest to name. As Goodglass et al. note, if vocabulary "difficulty" were the distinguishing criterion, then the order of errors would have been the same in both expressive and receptive performance modalities "because the same words are used in both" (p. 85). This not only suggests differences among word categories, but it also implies that the disparity in phonological information between letters and numbers places a greater information encoding load on the speaker for numbers, but a greater load for decoding on the listener for letters. The fact, that different types of aphasias have resulted in the loss of these different classes of words led Goodglass et al. (1966) to draw the following conclusion:

> In view of the predominately anterior location of lesions for Broca's aphasia and posterior site of the lesions in fluent aphasia, it seems natural to consider an anatomical basis for our findings. It is possible to postulate that word-finding system is subdivided anatomically according to the psychological character of different word categories. Thus, we might assign letter naming to anatomic structures which are more likely to be injured or isolated in Broca's than in fluent aphasia. (p. 87)

Poeck and his colleagues (Poeck, Hartje, Kerschensteiner, & Orgass, 1973) studied the relative impairment of three sorts of semantic categories in different kinds of aphasia (described as amnesic, motor, sensorys and global): colour names, body-part names, and object names. They examined these through comprehension as well as through naming. For the comprehension test with body parts, they asked each aphasic patient to point out as named parts of the body in a diagram and on their own body. Furthermore, for comparison, Poeck et al. administered a test in which the aphasics had to point out from their spoken names pictured objects out a choice of four. Since pointing to parts of the body on a diagram or on their own bodies resulted in similar errors, these results were combined. Of importance for the question of whether or not categories are separately impaired was the finding that comprehension of object names also followed the same pattern. In fact, the correlation between the comprehension of object names and that of body parts was as high as that between the two forms of comprehension of body parts. That is, patients with good understanding of body parts had good comprehension of object names and those with poor comprehension of body parts had poor comprehension of names. Poeck et al. maintain that this result does not necessarily support the claim that aphasics find it harder to identify parts of a whole, due to a general difficulty in the analysis. However, with respect to the human body at least, the names of parts seemed to be identified in the same way as the names of autonomous whole objects. When aphasics make errors in pointing out parts of their own body by name, it cannot necessarily be inferred that they have specific impairment in the sense of the spatial relations of their own bodies. The difficulty is more likely to be related to their general difficulty with all names.

Poeck et al. obtained similar results when they examined the comprehension of color names, performance on which correlated highly with comprehension of object names and body-part names. When they tested colour names through the aphasic patients' abilities in producing names rather than in comprehending them, they also found results which supported this conclusion. The results of colours were compared with aphasics's ability to name pictured common objects (e.g., *apple*, *house*, *shirt*, *telephone*, *watch*). Although the different types of patients differed in the nature of the naming errors they made (i.e., anomic patients were self-correcting, Wernicke's were not, while Broca's and global aphasics produced phonemic distortions), the number of errors made by each group was not significantly different. Likewise, there were no differences in the pattern of naming difficulties. All the groups found the colours slightly more difficult to name than the objects. In each group the majority of individual patients found colours harder to name than the objects, although in the Wernicke's group this difference was not significant. However, Poeck et al. claim that in the few examples of patients making more errors with object names than colours, the difference was not great enough to be of diagnostic significance. In general, as colour naming tends to be more difficult than object naming, there is no support for the concept of specific colour aphasia.

While extensive research is available concerning normal speakers' categorizing abilities, not until relatively recently has any consideration been given to investigating category membership in aphasic patients. Grossman (1978; 1981), Grober, Pereceman, Kellar, & Brown (1980), and Whitehouse, Caramazza, & Zurif (1978) have assumed a model of semantic-lexical organization that is not based on hierarchical arrangement of semantic features, but is rather organized around prototypical instances of a semantic category. The ability to classify an instance into its appropriate semantic category presupposes that conceptual information about the instance is intact. Differences in the accuracy of category decisions may reflect differences in the status of underlying lexical knowledge. Results with normal speakers indicate that typicality is an important aspect of the organization of semantic categories (see Rosch, 1975; 1978).

Whitehouse, Caramazza, and Zurif (1978) adapted Labov's (1973) study, which had been designed to investigate normal speakers' construction of conceptual category boundaries among closely related items, to examine the use of perceptual and functional information by aphasics in determining category membership. More precisely, they had anterior aphasics and posterior aphasics, the latter chosen particularly for their anomic behaviour, name a series of pictures that were variations of a model cup (a modification of Labov's paradigm) designed so that some looked more like bowls and others more like glasses. The functional context was also varied by depicting a coffee pot pouring coffee, a cereal box pouring cereal or ice water pouring from a pitcher into the container, so as to provide "cup", "bowl" and "glass" contexts. Twenty-four drawings of containers were constructed so that, in a continuous scaling through gradual changes in shape, six drawings were changed from a prototypical cup to a bowl by adding to the width dimension. Similarly, six other drawings ranged from the prototypical cup, by increasing the height dimension, to a glass-like container. In addition, 12 of the 24 drawings along the scale had handles and the other 12 did not have handles.

Whitehouse et al. set these drawings so that the three contextual (coffee, cereal, ice water) pictures could be fit to the container drawings so that together they both appeared as one picture of some food substance being poured into some container; thus functional contexts and shapes could both be varied. Each possible container was shown to the aphasic patients in all possible contexts and once with no context (neutral). While looking at each combined picture (container and context), the aphasics were offered a name (*bowl*, *cup*, or *glass*) presented orally and asked to indicate by raising their hands when the desired label was uttered. Essentially, the question was whether the two types of aphasics would differ in their ability to categorize the containers on the basis of perceptual and contextual information.

The results showed that the anterior aphasics, like normal speakers, named the clear (prototypical) examples of each type of container consistently and also the borderline one consistently. Functional information is especially useful in the borderline cases in which the perceptual features of the object yield a picture, for example, which is neither a clear-cut bowl nor cup. In these cases, functional information is used to decide between the two possible names. It would appear that the task requires a sensitivity to category boundaries (i.e., whether an item is a goood example or a borderline instance of some category) and demonds an ability to integrate perceptual and functional information in determining category membership. The anterior group was demonstrably sensitive to the contextual information in that they appropriately changed the object name with shifts in context. In contrast, the posterior aphasics (anomics) either named all items (objects) inconsistently or based their name selection on one feature (i.e., the presence or absence of a handle), without regard to the object's typicality of a particular category, and appeared largely unable to use functional information to name objects. In other words, the posterior aphasics could apply the correct label to model object shapes, but the label usually hinged on one or another perceptual attribute and was not varied, either in the face of conflicting functional information or even in the face of perceptual information. For example, one patient used the name *cup* for all object shapes, no matter what the functional context was, as long as a single handle was part of that shape.

Other evidence regarding knowledge about category membership in aphasics comes from three recent studies by Grossman (1978; 1981) and Grober et al. (1980). All three studies applied Rosch's (1975) model of lexical organization to investigate whether aphasic patients are sensitive to the typicality effects observed in normal subjects. To test Rosch's prototypicality model of semantic organization in aphasic patients, Grossman (1978; 1981), using a category-naming task, asked both non-fluent and fluent aphasic patients to name as many items as possible from a number of Rosch's superordinate categories (e.g., birds, fruit, furniture, vehicles, tools), and evaluated the patients' responses on the basis of prototypicality norms established by Rosch. It was expected that the aphasics' order of naming of high and low prototypical referents would reveal differences between the two aphasic groups and that the aphasic groups would show no difference in their use of both high and low prototypical referents. Although both studies by Grossman are referenced, the discussion will be restricted to the Grossman (1981) study only, which is a replication and extension of the Grossman (1978) preliminary findings.

Grossman's (1981) results reveal that both groups of aphasics produced both typical and atypical members of each category. The fluent aphasics not only were less sensitive to central instances of superordinates, but they went beyond what normals often considered a reasonable extension of the word. After having produced high typical items initially, they gradually shifted to the category boundary and ultimately named items that were atypical members of the category, occasionally including instances that were out of the category (e.g., items like *beaver* and *squirrel* were included as exemplars of birds). That is to say, the fluent aphasics inappropriately listed items that were not members of the designated categories, demonstrating the "broadening of the semantic organization of the lexicon" (p. 327) and exhibited "only a superficial appreciation of a referential field's central portion" (p. 327).

Conversely, the non-fluent aphasics did not follow such a pattern with regard to typicality and named primarily representative exemplars of each semantic category. For example, they regarded the names of highly representative birds like *robin* and *sparrow* as exemplars of bird, but rarely the names of less representative birds like *goose*, *swan*, or *duck*. Grossman (1981) states that this study lends support specifically to the notion that neither group of aphasics relied on a definition-like feature to determine what a word can refer to:

> The non-fluent aphasics may rely on a comparison between the ideal instance of "bird" and the potential instance; the fluent aphasics may base their referential hypotheses in part on the minimal criteria associated with the spanning constraint and form class membership constraint. (1981, p. 329)

In context of these findings, the importance of typicality to posterior aphasic patients' performance with superordinate categories found by Grober, Perecman, Kellar, and Brown (1980), is not so surprising. Grober et al. (1980) not only assumed that lexical knowledge of categories is represented in the subjective lexicon by a set of semantic features, but also that semantic features are of two types, namely, defining or essential properties of a concept, which are systematically applied throughout the lexicon, and characteristic features, which are less central to a word's meaning and are referential or affective in nature. The difference between typical and atypical members of a semantic category derives from the distinction between defining and characteristic features (see Smith et al., 1974). Typical instances are good members of a category since they possess all of its defining features as well as many of its characteristic ones. Atypical instances, on the other hand, possess primarily defining features and so are less representative of the category. The difference between related and unrelated members involves a similar distinction. Instances related to the category have many of the characteristic features of the category but none of its defining ones; unrelated instances have no features in common with the category.

Grober et al. designed two tasks to access the status of semantic categories in aphasic patients with anterior and posterior pathologies. The tasks were identical with the exception that simple line drawings were used in Experiment 1 and their written names in Experiment 2. A picture or a printed word appeared on each trial and the subject had to decide whether or not the item presented was a member (or instance) of a particular pre-specified superordinate category and to indicate his or her decision nonverbally. Positive response items consisted of typical instances from five semantic categories selected from the Rosch (1975) study. There were two types of negative responses: instances drawn from a category related to the target category, and instances drawn from unrelated categories. For example, 4 typical and 4 atypical instances from the category of tools were combined with 4 instances from the related category of weapons and with 4 instances from unrelated categories. These 16 items were randomly presented in a single block.

The results indicate that both groups of aphasic patients performed at a high level of accuracy when classifying typical category members or unrelated members, but at the category boundary, where the membership in a category is fuzzy, their performances diverged. While the anterior aphasics maintained relatively high levels of accuracy, the posterior aphasics failed to do so. In other words, while the performance of anterior aphasics was indistinguishable from that of normal controls, indicating that the underlying representation of semantic categories is preserved in anterior aphasics, the performance of posterior aphasics showed that it is disrupted most severely for items that belong to different, but closely related categories.

Grober et al. interpreted their results in terms of the distinction between defining and characteristic features (see Section 2.4.2.2. of this Chapter), namely that, typical instances are good members of a category because they include both defining and characteristic features, whereas atypical instances involve primarily defining features. Characteristic features often represent idiosyncractic referential and affective attributes of a concept that are not essential to its meaning in any systematic way. These factors, according to Miller (1972), grow out of a speakers' experience of the word rather than from his knowledge of the language. Given this interpretation, it may be that posterior aphasics rely on characteristic features and consequently perform best with typical members of a category; their lexical knowledge is organized around personal situations and subjective experiences (e.g., one patient said of an airplane, "I can't drive it, so it's not a vehicle"). Although the more defining features, which normally relate words both within and across semantic categories, are no longer available to posterior aphasics as a basis for deciding semantic classification, they rarely made mistakes when categorizing, since the overlap between characteristic features of the member and those of the category were so large. In sum, Grossman (1978; 1981) and Grober et al. (1980) have shown that patients with posterior damage tend to have more difficulties with low-typical than with high-typical members of a category (Rosch, 1975), and that disruption of the normal structure is not evident in the performance of anterior/non-fluent aphasic patients.

2.5.4 Summary of Aphasic Research

In the area of the lexicon and semantics, there is a general reduction of vocabulary in all language modalities in aphasic patients. Non-fluent (anterior) aphasics appear to retain the ability to process language in terms of its concrete meaning (i.e., its relation to perceptual objects and events), while suffering disruption at a more abstract syntactic level. Conversely, fluent (posterior) aphasics are more likely to retain syntactic habits but show disruption in their processing of the concrete perceptual attributes of language. In the extreme case, the latter problem may be a loss of the referential connection between a specific perceptual attribute (e.g., colour) or an entire concept and its name. More often, there seems to be a disruption of the relationships among attributes.

Several conclusions may be drawn from the aphasic literature reviewed above. When errors are made in naming they commonly are confusion of words associated in meaning or experience (Schuell & Jenkins, 1961). The semantic confusions of aphasic speakers seem to correspond to a considerable extent to the free word associations of normal speakers (Rinnert & Whitaker, 1973). If an aphasic makes an erroneous response in a naming task, it is likely to be a high associate of the correct response (e.g., substitution of *comb* for *brush*). In fact, when non-fluent aphasics are asked to simply produce associations of words, their typical responses are essentially the same as those of normal speakers, although they produce fewer associations and produce them more slowly (Howes, 1967). Word associations given by non-fluent aphasics correspond closely to those given by normal subjects, whereas those produced by fluent aphasics appear bizarre.

Studies of word frequencies in large samples of aphasic speech show that word distribution is not basically different from that of normals speakers, but is shifted in the direction of reduced variety; the magnitude of the shift is proportional to the degree of severity of aphasia, that is, proportional to the extent of damage to brain structures (Howes, 1967). What is observed is a loss of the less general, less frequent words in the language and overuse of high frequency words (i.e., nouns, verbs, modifiers) (Wepman et al., 1956). The Wepman et al. data reveal a lack of precision in the use of all content words, with word frequency a critical factor.

When aphasics are asked to rate how similar pairs of words are in meaning, their responses are similar to those of normal speakers, although they are guided more by connotative than conceptual features (Zurif et al., 1974). These and other data (Epstein, 1975; Lhermitte et al., 1969), which postulate that lexical memory is organized in terms of internalized data structures based on semantic features, suggest that compared with the lexical structure underlying normal language use, the semantic representation in anterior aphasics is more restricted in its range of conceptual integration. Zurif et al. (1974) found that what appeared to be a somewhat restricted semantic system with an increased influence of affective and situational variables for anterior aphasics. Posterior aphasics displayed even less ability to organize lexical items by features.

Evidence by Goodglass et al. (1966) indicates that word finding is a function of the semantic category of words involved, objects being the easiest to comprehend, and letters the most difficult; but objects being the most difficult to name and letters the easiest. In auditory comprehension, this relationship was, however, reversed, eliminating the possibility of a simple explanation in terms of word frequency. This not only suggests differences among word categories, but it also implies that difficulty of a particular category may vary between input and output. The study also found some differences in the pattern of naming performance across the semantic word categories between fluent and non-fluent patients; the fluent aphasics were deficient in object naming and superior in letter naming.

Using a visual-auditory task involving recognition of several semantic categories, Goodglass and Baker (1976) found reduced differences between normal controls and high comprehension aphasics (anterior aphasics), but not low comprehension aphasics (posterior aphasics). They interpreted their results as indicating that naming is probably determined by convergence of associations which is reduced in aphasics. Again, the severity of comprehension appears to be more predictive of semantic processing efficiency than specific semantic structure.

Still, other studies have used Rosch's notion of prototypicality to investigate the lexical structure underlying aphasic normal language use (Whitehouse et al., 1978; Grossman, 1978, 1981; Grober et al., 1980). Whitehouse et al. (1978), who explored the ability of aphasic subjects to integrate perceptual and functional information about a stimulus item in order to find its name, have found a decreased knowledge of the functional and perceptual features of objects for fluent aphasics, whereas non-fluent aphasics appear in this regard to closely approximate normal subjects. In the same vein, Grober et al. (1980), examining category membership in aphasics, have demonstrated that the underlying representation of semantic categories is generally preserved in anterior aphasics but disrupted in posterior aphasics. The posterior aphasic group performed much more poorly at categorical boundaries and appeared to selectively disregard defining features, while placing complete reliance upon idiosyncratic characteristic features that tie the word more closely to personal situations and subjective experiences.

These findings of qualitative differences between groups of aphasics on a measure of semantic comprehension concurs with much of the literature surveyed. The performance of fluent aphasics does not correspond to normals in structuring of semantic categories, and it appears that the source of naming disruption at least for fluent aphasics, is at the level of semantic representation. Even though it is the case that in all of these studies non-fluent aphasics demonstrated noticeable deficits, the conclusion that their performance reflects changes in the underlying structure of the patient's lexicon does not seem all that clear. The same pattern of impairment, namely an inability to use the more general and abstract defining features, with a tendency to rely on the more concrete and idiosyncratic characteristic features, has been considered by Zurif et al. (1974) as typical of anterior aphasic patients and by Grober et al. (1980) as characteristic of posterior aphasic patients. Furthermore, taking into account the few studies that have assumed typicality to be an important aspect of the organization of semantic categories, we can see that they point to a disruption of typicality at least in posterior aphasic patients, but give a rather inconsistent account of their disorganization. According to Grossman (1981), posterior aphasic patients are unable to anchor the category to its prototypical instances, since they "do not appear to accord the names of central instances any special status" (p. 329), whereas according to Grober et al. (1980), the prototypical members of a category are well classified by posterior aphasic patients who showed a difference from normals only at the boundary where the membership in a category is fuzzy. Therefore, this researcher was encouraged to undertake this study to further examine the nature of semantic structures of anterior/non-fluent and posterior/fluent aphasics in comparison to normal language speakers, but instead employing several modes of representation (concrete versus abstract representation) of lexical information from a particular semantic category. The nature of this research will be discussed in detail in the following chapter.

3. EXPERIMENTAL METHODOLOGY

3.1 Introduction

This chapter is devoted to the description of the experimental methodology utilized to investigate the conceptual organization underlying word meaning and the effect of the different accessing modalities on aphasic and non-aphasic control subjects' perception of the relations among a set of items presented for consideration.

Similarity judgements of words, of pictured items, and of real objects, a method applied in earlier studies for collecting data about lexical meaning, was used in this study to examine the subjective lexicon underlying vegetable terms. This procedure, used by Fillenbaum and Rapoport (1971) and later modified by Baker (personal communication), is a rating task which requires subjects to make direct judgements about similarity of meaning among a set of related items. The judgements made are not absolute, but simply relative to the set of items actually given to the subjects.

One way of gathering such information is to ask subjects to express their similarity/difference judgements in terms of a nine-point "similarity of meaning" scale, on which a rating of "1" is given to word pairs which are "most similar" in meaning, while a "9" is assigned to "most different" word pairs. Intermediate scale values represent various degrees of closeness in meaning. The technique is demonstrated in the following description of the investigation of a set of vegetable terms, which served as a pilot study for the main study reported in this thesis. The terms in the study were: *broccoli*, *cabbage*, *carrots*, *lettuce*, *onion*, *parsley*, *radishes*, and *tomato*. Subjects were asked, on an individual basis, to make judgements about the similarity and difference of the words in the set compared by pairs. In the pilot study the actual presentation of the terms was a computer-generated upper triangular randomized matrix in which each lexical item in the set is compared with every other lexical item in a given set.

The first step in this procedure is to scan the entire list of words to find the pair of words judged to be most alike in meaning, and next, scan to find the pair considered to be most different in meaning, assigning a 1 and 9 respectively to these pairs. In terms of the pilot study lexical set, a 9 might be assigned to the pair *broccoli*:*tomato* and a 1 to *cabbage*:*lettuce*. This initial step sets anchor points for the ends of the scale and at the same time encourages subjects to make use of the whole scale in assigning judgement ratings. Following this anchoring, subjects are then free to use the values of 1 and 9 inclusive to express their estimates of the closeness of meaning for all other pairs of terms. The only constraint is that each subject must have at least one "1" and "9" rating in his or her matrix. Subjects then proceed to complete the judgements on the whole set, and these numbers serve as the raw data for statistical analyses. The rationale underlying semantic similarity judgements is, first, that an analysis of the ratings may reveal subtle dimensions within the entire set of words, and second, it allows subjects to indicate the degree to which they feel two words are semantically related so that it is possible to discover individual differences among subjects with regard to the word meanings.

This technique produced, from the pilot study, interpretable results (reported below) which suggested that the vegetable field was a useful stimulus set. However, the method of presentation and the use of the "similarity of meaning" scale had to be modified for the aphasic subjects in the main study since they experienced extreme difficulty in using the entire scale to rate the similarity of meaning of the pairs of vegetable terms presented to them. Hence, the triadic comparison procedure, a useful technique particularly apt for examining internalized data structure in aphasic patients (Epstein, 1975; Zurif et al. , 1974), was employed in this experimental investigation of the subjective lexicon. The triadic comparison technique is discussed in detail below, but note that the results of the two techniques are similar, i.e., both yield measures of judged distance between elements in a set.

3.2 Method

3.2.1 Subjects

Two groups of subjects participated in this study: a group of aphasic patients and a group of non-aphasic control subjects. Subjects with no medical history of neurological damage and no disorders in either language or consciousness comprised the normal control group. They were chosen on the basis of their similarity in age, sex, and educational level to the experimental group (i.e., aphasic patients). The non-aphasic control group consisted of 11 females and 4 males (N=14), who ranged in age from 19 to 87 years, with a mean age of 52.64 (sd=22.00). Their educational level ranged from completion of Grade 10 to completion of 6 years of University (mean=13.36 years of schooling; sd=2.47). This closely approximated the mean level for the experimental group of aphasic subjects. Information concerning the normal subjects' sex, age, educational level, and languages known since childhood is given in Table 3.1.

The aphasic population (see Table 3.1) consisted of 12 patients (6 males and 6 females) with injury to the left hemisphere. Each had been unequivocally diagnosed aphasic by the neurological staff at the Edmonton hospital at which he or she was currently being seen. All of the aphasic patients were enrolled in a professional speech therapy program at the time of testing, either at the University of Alberta Hospital or at the Glenrose Hospital in Edmonton, 4

TABLE 3.1

Descriptive Data for Normal Control and Aphasic Subjects

Groups	No.	Sex		Age Range	Educational Level	Languages Known	Age Categories
		F	M				
Normals	14	4	10	19-87	Grade 10 to University Level	Bengali Dutch English** French Ukranian	(7) Young Adults (2) Middle Aged Adults (3) Senior Citizens
Aphasics	12	6	6	19-85	Grade 7 to University Level	English** French German Norwegian Ukranian	(2) Young Adults (3) Middle Aged Adults (7) Senior Citizens

** Mother tongue was English or had used English since childhood.

as in-patients and others (N=8) as out-patients. Ten of the patients were tested by the experimenter at these hospitals, while two of the patients receiving speech therapy at the University of Alberta Hospital were tested at their place of residence (St. Joseph's Auxiliary Hospital, Edmonton). The period of time between onset of the speech disorder and time of the experimenal testing ranged from 1 month to 2 years, 4 months (mean=10.64 months; sd=9.85), with the exception of one patient whose brain damage was sustained following a drug overdose in 1975 (post onset=5 1/2 years).

There were no restrictions made in the choice of aphasic patients based on etiology. Therefore, the aphasic sample consisted of subjects with brain damage resulting both from trauma and from vascular disease, as well as one from a drug overdose. The etiology of the speech deficit was known in all of the cases: 2 patients sustained a traumatic injury to the head (2 fluent, posterior aphasics), a 1 drug overdose (a non-fluent, anterior aphasic), with cerebrovascular accidents (CVA's) accounting for the remaining 9 (5 non-fluent, anterior aphasics and 4 fluent, posterior aphasics) (see Table 3.2). Whatever their classification, however, all of the aphasics in the experiment were capable of comprehending the task. This was demonstrated by the use of the simple training tasks. A criterion for inclusion in the experiment was the ability of each subject to understand simple auditory and visual commands. The aphasic patients, as a group, were somewhat

TABLE 3.2

Descriptive Data for Aphasic Subjects

Subject	Age	Sex	Years of Education	Languages Known	Diagnosis	Time Onset of Aphasia (years; months)	Etiology	Current Status
1. CA	19	M	12	English	Fluent (posterior)	0; 1	Trauma	Acute
2. MB	63	F	14	English	Non-fluent (anterior)	2; 4	CVA	Chronic
3. JC	85	F	16	English	Non-fluent (anterior)	0; 1	CVA	Acute
4. MC	73	F	12	English	Fluent (posterior)	0; 8	CVA	Chronic
5. RF	58	F	10	English French	Fluent (posterior)	1; 4	CVA	Chronic
6. BM	36	M	7	English	Fluent (posterior)	5; 6	Drug Overdose	Chronic
7. EN	72	M	12	English German	Fluent (posterior)	0; 2	Trauma	Acute
8. LP	67	M	16	English French	Non-fluent (anterior)	0; 8	CVA	Chronic
9. PS	66	M	12	English Ukranian	Fluent (posterior)	0; 6	CVA	Acute
10. MS	75	F	10	English Norwegian	Non-fluent (anterior)	1; 2	CVA	Chronic
11. MB	68	M	10	English French	Non-fluent (anterior)	2; 4	CVA	Chronic
12. MW	63	F	12	English	Non-fluent (anterior)	0; 5	CVA	Acute

older in age than the normal control subjects ranging in age from 19 to 85 years, with a mean of 62.08 (sd=17.94). In educational level, they ranged from Grade 7 to University (B.A.), with a mean of 12.17 years of schooling (sd=2.17), which was not significantly lower than that of the normal control group. However, 4 of the aphasics had not completed high school compared to 2 subjects in the normal control group.

In selecting the aphasic population, four conditions had to be fulfilled in order that a subject qualify for inclusion in the experiment:

1. that there be evidence of aphasia, i.e., a subject had incurred injury to brain tissue with subsequent damage to speech and language processes;

2. that the patient must be older than 15 years of age;

3. that the patient must be a native speaker of English or have used English since childhood; and

4. that the patient must not have any additional problems such as chronic illnesses, dementia, confusion, or visual impairment that would interfere with the experimental task.

In addition, all subjects had to demonstrate an ability to read single words, understand auditory instructions, and perform satisfactorily on the short practice session or pre-test included in the experimental protocol.

3.2.2 Stimuli

The stimulus materials in the experimental task in this study were based on 8 items drawn from the semantic domain of common vegetables. The choice of items included in the vegetable set was a subjective decision, in part determined by the availability of vegetables throughout the year, since initial testing started during the winter season and continued on into the summer. Thus, the following 8 vegetable terms comprised the semantic set: (1) *broccoli*, (2) *cabbage*, (3) *carrots*, (4) *lettuce* (iceberg), (5) *onion* (brown), (6) *parsley*, (7) *radishes*, and (8) *tomatoes*. The experimental condition consisted of three subtests in which the items were presented to subjects in three modalities: the actual objects (vegetables themselves), pictures of the objects, and verbal labels for the objects. The bright and colourful pictures of the vegetables were obtained from seed packages. The words for the vegetables were printed in lower-case letraset black lettering (1/2" height, 1/8" thick). Subsequently, the 8 pictures and the 8 words were individually mounted on 16 6x6 inch cards (see samples in Appendix A).

3.2.3 Procedure

As noted above, the exploration of subjective lexical organization in this study was based on a triadic comparison procedure. The subtest using the vegetable *names* (words) will be described to illustrate the procedure. The other two subtests were carried out in the same fashion.

Three word cards were arranged in a triangular fashion on a table in front of the patient. The triangular array was used to prevent choice on the basis of adjacency. Each word was placed in combination with every other pair of words once.[3] In the placement of words/items within each triadic array, care was taken that a word occurred an equal number of times in each point of the triad. The order of presentation of the triads was determined as follows: the list of triads was divided into thirds. In the subject's first test, they were presented in order of 1, 2, 3; in his/her second test, 2, 3, 1; and in his/her third test, 3, 1, 2. This was done to control for any effects of order and fatigue. The subject was then asked to select the two items tha seemed most similar to him or her by simply pointing.

The use of the triadic comparison procedure involves the assumption that the words to be clustered are conceptually distinct to the subject. This assumption becomes critical when one is dealing with an aphasic population, and so utmost care was taken to demonstrate what was demanded of each subject in the task. For subjects to settle on two words, pictures, or objects in each triadic array, they presumably ignore some of their distinguishing features or dimensions while attending to others. "The fewer the features distinguishing two terms or the less important these features, the more likely that the terms will be assigned to the same group. The issue then becomes one of trying 'to discover which conceptual features have been ignored, and thus, by indirection, what the features are'" (Fillenbaum & Rapoport, 1971, p. 187). By this reasoning, this procedure may be used to infer which features subjects are using as central to the subjective lexical organization of the test set.

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[3] While 8 terms require 56 different triadic arrays to make all possible comparisons, by oversight only 52 were presented. However, the resultant structures from these 52 presentations were not noticeably different from those obtained in the pilot study comparing all possible pairs of terms. Consequently, it was decided that the reduced data set could reliabily be used for the investigation. Therefore, the results reported here are obtained with the stimulus set of 52 triadic arrays shown in Appendix B; the 4 missing arrays are also noted there in a footnote.

Before starting with the main task (the vegetable terms), a short demonstration and practice session was undertaken to familiarize subjects with the experimenal task. In these pre-test tasks, subjects were presented with three sets of examples: two of coloured paper and one of black felt pen drawings of geometric shapes. The first example, conveying the notion of colour, consisted of two blue circles, varied in saturation, and a yellow circle, different in hue; the second example, conveying the notion of shape, was comprised of two rectangles, varied in shape slightly, and a triangle; and the third example, conveying the concept of size, include three pink star shapes, two slightly different small ones and a large one. In each example set, the three items were presented in a triadic array; however, the position of the "most different" item was varied in each set. The practice session stimuli differed from the experimental triads in subject matter only. It was believed that if a patient demonstrated good performance on these practice session tasks, then he or she would be able to perform on the main task, even though the organizational dimensions of the main test set were less obvious.

With respect to the main tests, the three subtests were administered, varying in the order of their presentation from subject to subject. In each subtest, a subject was presented with triads of words, pictures or objects from the vegetable set, and was asked in each case to simply point to the two items that he or she felt were most similar. The subtests were administered several days apart (3-4 days) and each lasted approximately 30-45 minutes. A testing session could be interrupted at any time if the subject was fatigued and continued after a short break or on another day. Unlike the normal control subjects, almost all of the aphasic patients required two sessions to complete a subtest. A test was sometimes begun in the morning and completed in the afternoon or on the following day.

In order to discover rather than impose the dimensions, the attributes on which the stimuli are to be judged are carefully not specified. Thus "similarity" was not defined to the subjects even though they were required to make judgements using this criterion. Instead, they were encouraged to choose their own meaning components for making comparisons. Once the subject had made a choice for each triadic array presented to him or her, the experimenter noted the two lexical items selected by the subject as being most similar. Subjects were assured time and time again that the experimenter was soliciting their opinions only and that this was not a right/wrong test.

3.3 Data Tabulation

The following is a description of the techniques employed in order to analyzed the data in this study. For each triadic array, the two lexical items chosen to be the most similar by the subject were tabulated until the tabulations for all the triadic comparisons were completed for each subtest for every subject. Subsequently, a separate "upper-triangular similarity matrix" was constructed for each subject's data, the cell entries in the matrix representing the number of times the subject had chosen each possible pair of lexical items as most similar. These frequency count scores of the occurrence of most alike combinations then served as raw data for the statistical analyses, and from them were constructed for each subject group and each modality an inter-subject distance matrix and a pooled similarity matrix of the mean judged distances between terms in the semantic set (see Appendix C).

3.4 Method of Data Analysis

Various methods of data analysis for ascertaining the dimensions of meanings of groups of terms have been performed on data of this nature. The most popular, multidimensional scaling (MDS) and hierarchical clustering (HC) procedures, present distinct structural model according to which one analyzes the similarity of meaning data. The rule of thumb suggested by Miller (1969) is to use a MDS technique, aimed at a dimensional representation, if one believes that the underlying organization of the data is linear or paradigmatic, and to use a hierarchical clustering technique if one believes that a taxonomic class-inclusion structure is involved (p. 129).

The fact that both multidimensional scaling and hierarchical clustering analyses may give equally accurate representations in many practical situations does not mean that these two methods always give the same kind of information about the data. To some extent they are in competition with one another. Much more, however, they stand in a strong complementary relationship. The key difference between MDS and hierarchical clustering is that MDS provides a spatial representation of the proximities (i.e., measures of similarities or dissimilarities), while clustering provides a tree representation of them.

First, since it was assumed that the vegetable terms investigated in this study contained features or dimensions that might be arranged into a hierarchical relation (i.e., not every term in the array has a value for every feature and certain features dominate others), the hierarchical clustering procedure (Ward, 1963; Johnson, 1967; Wishart, 1978) was applied to the judged-similarity data from the triadic comparisons. Clustering techniques seek to form 'clusters', 'groups', or 'classes' of individuals (based on a general factor, several common factors, and then several specific factors), such that individuals within a cluster are more 'similar' in some sense than individuals from different clusters. Many of the major varieties of hierarchical clustering procedures have been incorporated into a computer package (CLUSTAN) by Wishart (1978).

In general, the hierarchical clustering method applies a routing strategy to reproduce hierarchical structure in the data. The method forms an initial partition of N clusters (each object is a cluster) and in a stagewise manner proceeds to reduce the number of clusters one at a time until all N objects are in one cluster. In the initial stage, N minus 1 clusters are formed by enumerating the N taken 2 at a time possible fusions and selecting the one which optimizes the chosen criterion; in the second stage, N minus 2 clusters are formed in a similar manner, and so on. More precisely, beginning with the inter-subject similarity or distance matrix, the method fuses individuals or groups of individuals which are closest (or most similar), and thereby proceeds from the initial stage of N individuals to the final stage in which all individuals are in a single group. The result it gives may be presented in the form of a hierarchical tree or dendrogram, this being a two-dimensional diagram illustrating the fusions.

Secondly, in order to determine the strength of bonding or cohesiveness of each proposed cluster provided by hierarchical clustering, a cluster cohesion statistic (Baker, personal communication) was calculated. This statistic depends on two distance measures: the mean distance between the objects within a cluster (inner distance) and the mean distance between each of the objects in a cluster and all of the objects outside of it (middle distance) (Baker, personal communication). The compactness of a cluster can then be measured by the cohesion statistic which is calculated by the following formula:

$$1-(I/M)$$

where I is the inner distance and M is the middle distance. Thus, a cohesion score approaching 1 indicates a very cohesive distinct cluster (e.g., cohesion scores above .4 indicate good bonding or cohesion), while a score approaching 0 indicates the opposite.

Thirdly, a multidimensional scaling technique was used to enable the researcher to gain a better understanding of the total underlying pattern of interrelations in the data. The purpose of MDS is to represent stimulus objects as points in a space with a limited number of dimensions so that the distance between stimuli in the space corresponds as closely as possible to judgements of the similarity between stimuli (i.e., the more similar a pair are judged to be, the closer together they are in the space). It is typically assumed that if a set of objects is reasonably representative of the class which is of interest, the MDS of those objects reveals the psychologically fundamental and important dimensions which underlie the class. The appealing feature of the technique is that the measurement scales are not specified by the researcher and are therefore immune to his or her bias.

The 2-way MDS model described above has been extended to what has come to be called 3-way or "individual differences" MDS. This special method of multidimensional scaling, INDSCAL (Individual Differences Scaling; Carroll & Chang, 1970) was utilized in the analysis of the data since it makes use of individual differences between subjects in the weighting or salience of each dimension in the solution's perceptual space. From a 3-mode similarity matrix of n-by-n objects by N individuals, INDSCAL will yield two kinds of output matrices: one is the "group object matrix" defining the coordinates of input stimuli on each of the resultant unrotated dimensions in a group object space, and the other is the "subject matrix" defining weights of all object properties for each subject in the subject space. Hence, the INDSCAL dimensions exhaust nearly all underlying independent features actually used by all different subjects in judgements. When two subjects have identical weights (or pattern of weights) on all object dimensions, they are considered as having an identical structural contour of the private object spaces with the same underlying psychological dimensions used in the entire process of similarity judgements. Although it is assumed that subjects use a common set of dimensions, some of the dimensions may have little importance to some subjects. Since the dimensions that have the highest weights for some subjects can have low weights for other subjects, the model allows for considerable variation in multidimensional structures.

Finally, ANOVAR (analysis of variance with repeated measures) was performed to investigate whether there is an overall indication that the experimental conditions (subtests or modalities) produced differences among the means of the various groups (normal controls, anterior and posterior aphasics) depending on sex, age, educational level, languages known, and etiology and current status (where applicable). Comparison of variance between and within each of the categorical groups is central to the concept of ANOVAR. The overall logic of the procedure is that if the difference occurs in a set of group means, the variance in means between groups is going to be significantly larger than the variance within the groups. If the between group variance is larger relative to the within-group variance, the more likely it is that the groups were drawn from different populations. This means that the groups differ with respect to the dependent variable (i.e., measurements of subjects' performance on the three modalities) in question.

For each subject, the distances between his/her similarity matrices for each pair of modalities were calculated; that is, the distances between the matrices for pictures and real objects (PR), between pictures and words (PW), and between real objects and words (RW). These distances were arrived at by calculating, for each pair of matrices, the square of the sum of squares of differences between each corresponding cell in the two matrices. The exemplar formula for the calculation of the distance between a pictures matrix and a real objects matrix is:

$$dP,R = \sqrt{\sum_{j=1}^{n} (P_j - R_j)^2}$$

The resulting paired modality distance scores then served as raw data for the ANOVAR.

4. RESULTS

4.1 Data Analysis

Statistical tests were conducted to evaluate the experimental data collected from aphasics (anterior and posterior) and non-aphasic control subjects, and results of these tests are described in this chapter.

4.2 Results of CLUSTAN

4.2.1 Subject Groups

Assumptions underlying experimental research are based on the notion that subjects perform or respond to stimuli in a non-random manner. With this in mind, the author was interested in investigating the degree of inter-subject agreement in both the aphasic and normal control subjects in each of the three accessing modalities (or subtests).

The structuring of subjects into potential groups can be observed using the CLUSTAN package for hierarchical clustering. The inter-subject distance matrix makes it possible to determine whether subjects are operating on a common strategy, or whether distinct subject sub-groups exist. Applying Johnson's clustering technique to the distance matrix for normal subjects' processing of the pictures modality yields a tree structure such as the one shown in Figure 4.1. In this diagram, individual unclustered subjects are indicated by numbers at the bottom of the tree, and amalgamations are represented by horizontal lines. Hence, a "cluster" is any group of subjects subsumed under a horizontal link. As one moves up the tree diagram, the size of the clusters increases, but the degree of similarity on which the amalgamations are based decreases. At the top of the tree, all of the subjects have been amalgamated into one cluster. As one moves down the tree, clusters become smaller, and cluster members become more similar to each other.

Most clustering techniques require that reseachers decide on how many clusters exist in a data set. There must be a decision on how to evaluate a clustering solution, since a cluster analysis by virtue of its algorithm must yield a solution for a data set no matter how random the input numbers. Hierarchical clustering methods do not produce a discrete number of clusters, but rather a hierarchical arrangement between objects. Accuracy is calculated at the level where the number of clusters equals the number of underlying populations. For example, in Figure 4.1. if the accuracy of this cluster analysis were to be evaluated at the level where the number of clusters equaled the number of underlying populations, only two clusters would be considered. One cluster would contain 13 members (Subjects 1-12 and 14) and the other cluster would contain one member (Subject 13).

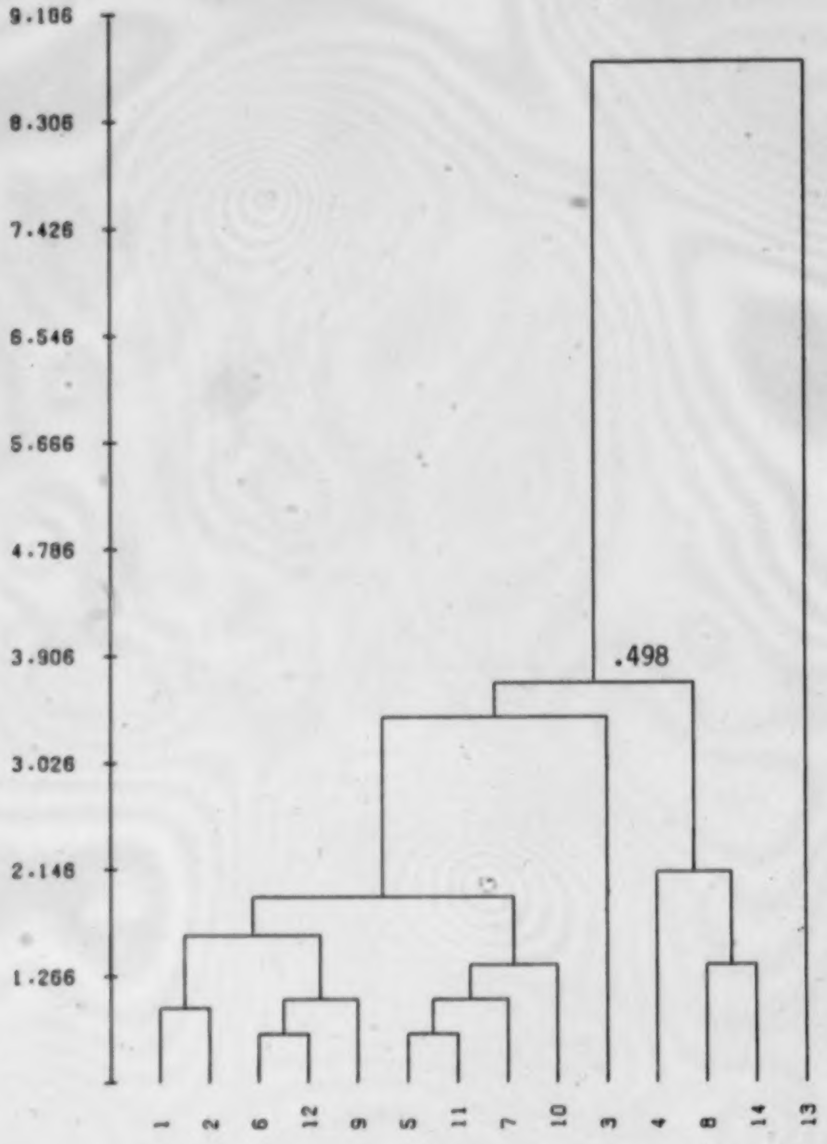

Figure 4.1. Normal Subject Profile Analysis: Real Objects Modality

In most practical applications of cluster analysis, however, Subject 13 would be considered an outlier who did not belong to any group. As one moves down the hierarchical tree, one distinct cluster can be identified, containing 13 members. In practice, this cluster is likely to be chosen as representing the subject "type" or natural grouping in the data. The situation becomes more complex when many subjects are being clustered and the probability of having extreme outliers increases.

The cluster cohesion statistic was used in conjunction with the visual display provided by the hierarchical cluster analysis to evaluate cluster structure. The cluster cohesion statistic determines the degree of cohesiveness within a putative cluster. A cohesion score of above .4 for clusters was regarded as representing good cohesion; scores below that value did not. In other words, the closer to 1 a cohesion score is the more cohesive and distinctive the cluster; 0 or less indicates that there was no distinction between a cluster and elements outside the cluster and that the subjects were not cohesive in responding to stimuli as a homogeneous group. Note that each hierarchical clustering diagram is accompanied by its respective cluster cohesion scores.

4.2.1.1 Normal Control Subjects

The three inter-subject distance matrices (for the respective subtests) for the normal subjects were subjected to a hierarchical cluster analysis utilizing Ward's method for clustering (Wishart, 1978). An examination of the hierarchical clustering schema of normal control subjects for the three subtests in Figures 4.1, 4.2, and 4.3, indicates, in summary, the following.

In the real objects subtest (Figure 4.1), all subjects except number 13 were homogeneous in their strategy. In the pictures modality (Figure 4.2), the majority of subjects behaved as a cohesive group, but six (Subjects 2, 3, 4, 14, 10, and 13) did not share this strategy nor use any other common strategy. In the words modality (Figure 4.3), all but four subjects (Subjects 2, 10, 3, and 13) used a common strategy, and the four did not share any other common strategy. The cohesion scores support this analysis.

In the real objects subtest, a one cluster solution with one outlier was considered as an accurate representation of these data, with a cohesion score of .498 (N=13) (see Figure 4.1). The real objects modality produced the highest degree of homogeneity of any of the three subtests with the normal population. It is interesting to note that Subject 13 was consistent in her aberrant similarity judgements throughout on the three subtests, being also a member in the second weaker cluster for the other two subtests.

The cohesion scores calculated for the two clusters in the pictures modality (Figure 4.2) were for Cluster 1 (N=8) .519 and for Cluster 2 (N=6) .090, indicating that subjects

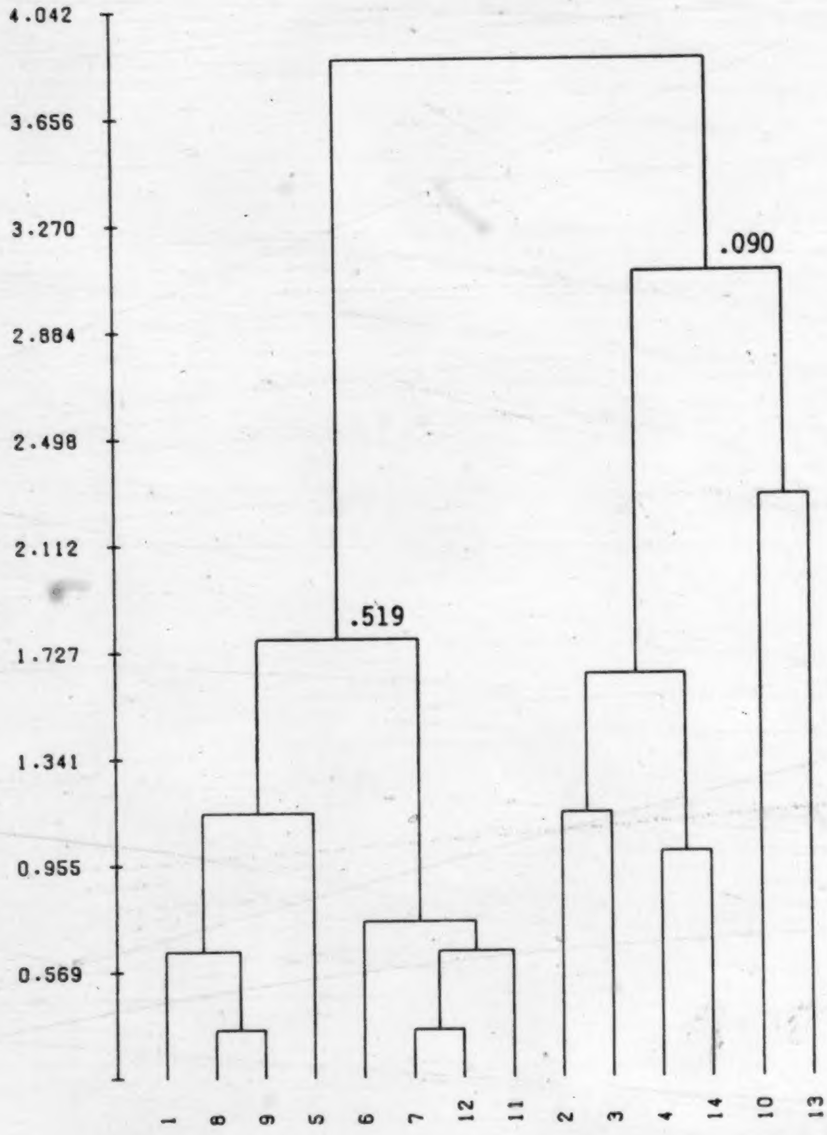

Figure 4.2. Normal Subject Profile Analysis: Pictures Modality

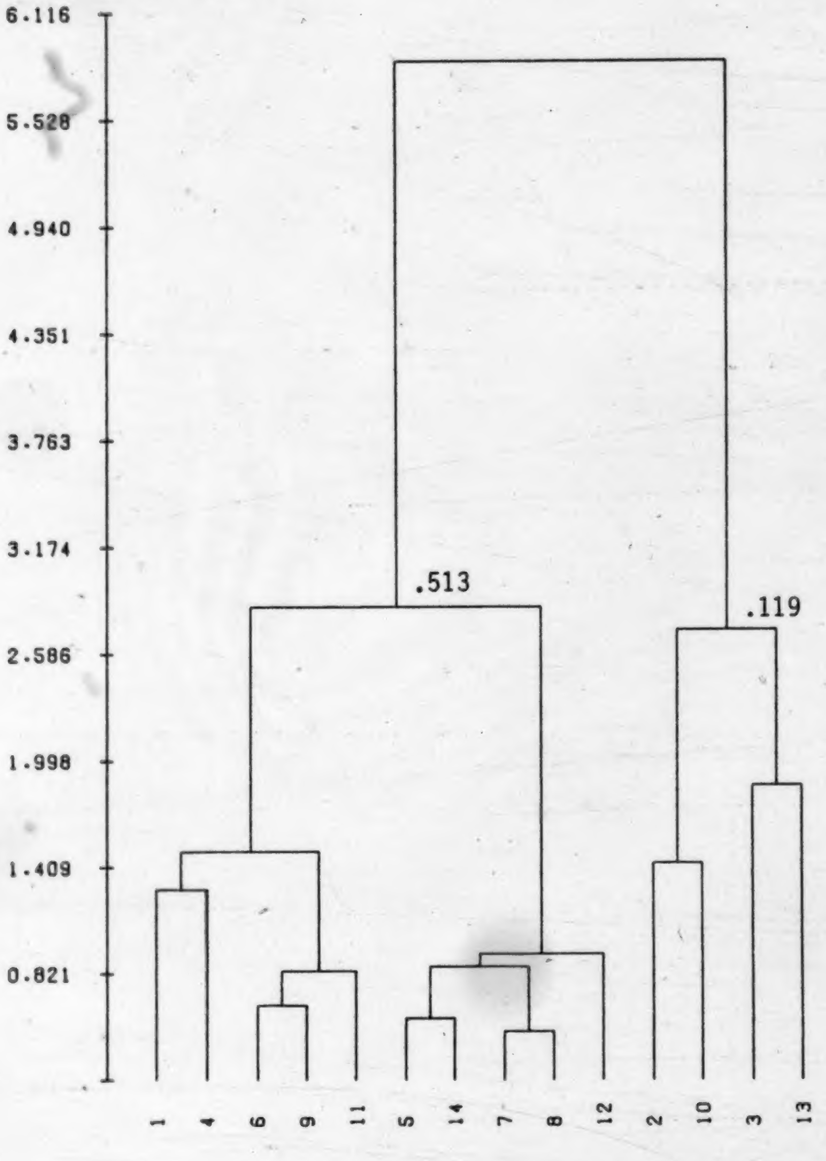

Figure 4.3. Normal Subject Profile Analysis: Words Modality

in Cluster 1 acted as compact distinct group and those in Cluster 2 did not. Those in Cluster 2 appeared to have used different strategies in their similarity judgements, both from each other and from their homogeneous counterparts. This subtest produced the greatest number of subjects (6) deviant from the common strategy. However, because these six did not share an alternative strategy, and because the homogeneous majority were strongly cohesive, a clearly-interpretable object analysis (of the terms in the semantic set) was obtained even on this subtest.

In the third subtest, the words modality, (Figure 4.3), two clusters again appear to emerge from the hierarchical clustering dendrogram. However, the cohesion scores calculated for Cluster 1 (N=10) and Cluster 2 (N=4) were .513 and .119, respectively, and again the second cluster was not distinct or sufficiently cohesive to consider the subjects as representing more than one population in their responses to the semantic similarity judgements.

In short, these results indicate that the normal controls were sufficiently homogeneous in their semantic similarity judgements to provide a basis for investigating the semantic structure of the object set (the eight vegetables) to provide normative base-line data for comparison with the aphasic subjects. This finding has already been suggested for the words modality, by the hierarchical clustering analysis of subjects from the pilot study (see Figure 4.4). In a scalar study such as the pilot

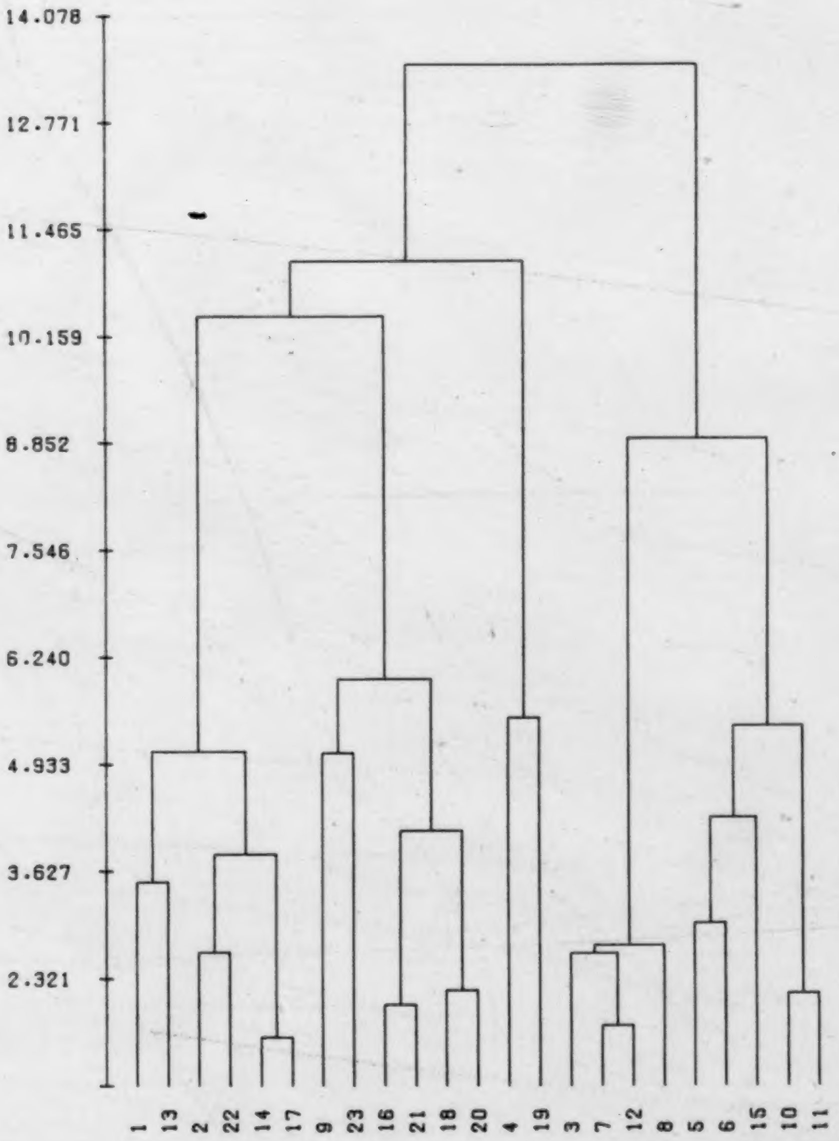

Figure 4.4. Normal Subject Profile Analysis: Pilot Study

study, a general guideline (Hunter, 1981) for evaluating cluster structure is to assume that clusters that cohere below the value (measured on the ordinate axis of the dendrogram) of two times the scale are cohesive. A nine-point scale was used in the pilot study. Note in Figure 4.4 that the cluster of all subjects is formed between 13.0 and 14.0.

4.2.1.2 Aphasic Patients

The three inter-subject distance matrices (for the respective subtests) for aphasic patients were submitted to the same cluster analysis technique (Ward's method, 1963). In comparison to the non-aphasic control subjects, as expected, the aphasic subjects showed less consistency as a group in all of the three accessing modalities (or subtests). The hierarchical clustering dendrograms for the aphasic subjects are shown in Figure 4.5 (pictures modality), Figure 4.6 (words modality), and Figure 4.7 (real objects modality).

Note that the aphasic subjects present a very different profile from the non-aphasic controls. The hierarchical cluster structures are much more diffuse, with clusters being formed much further up the tree than is the case for the controls. The cluster cohesion statistic confirms this impression. Only in the real object modality (see Figure 4.7) did any clusters cohere above the critical value of .4, and while there were two in this modality, one contained

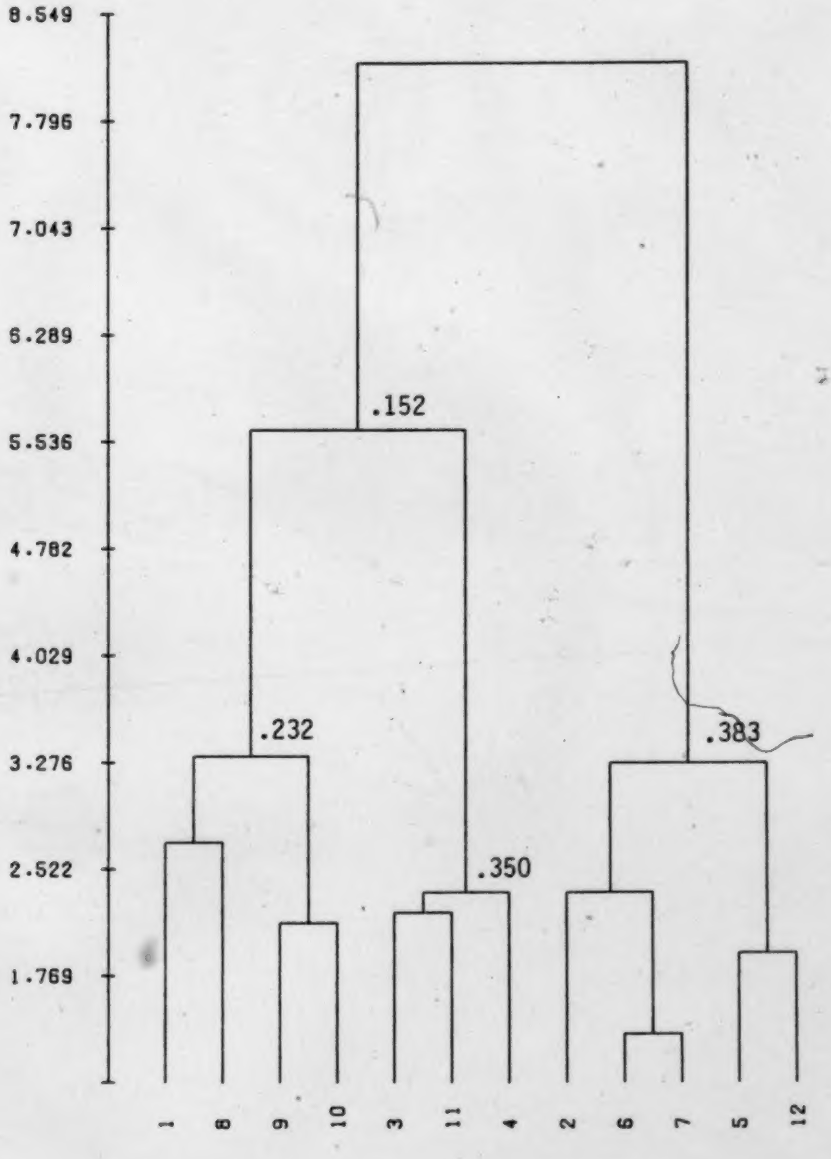

Figure 4.5. Aphasic Subject Profile Analysis: Pictures Modality

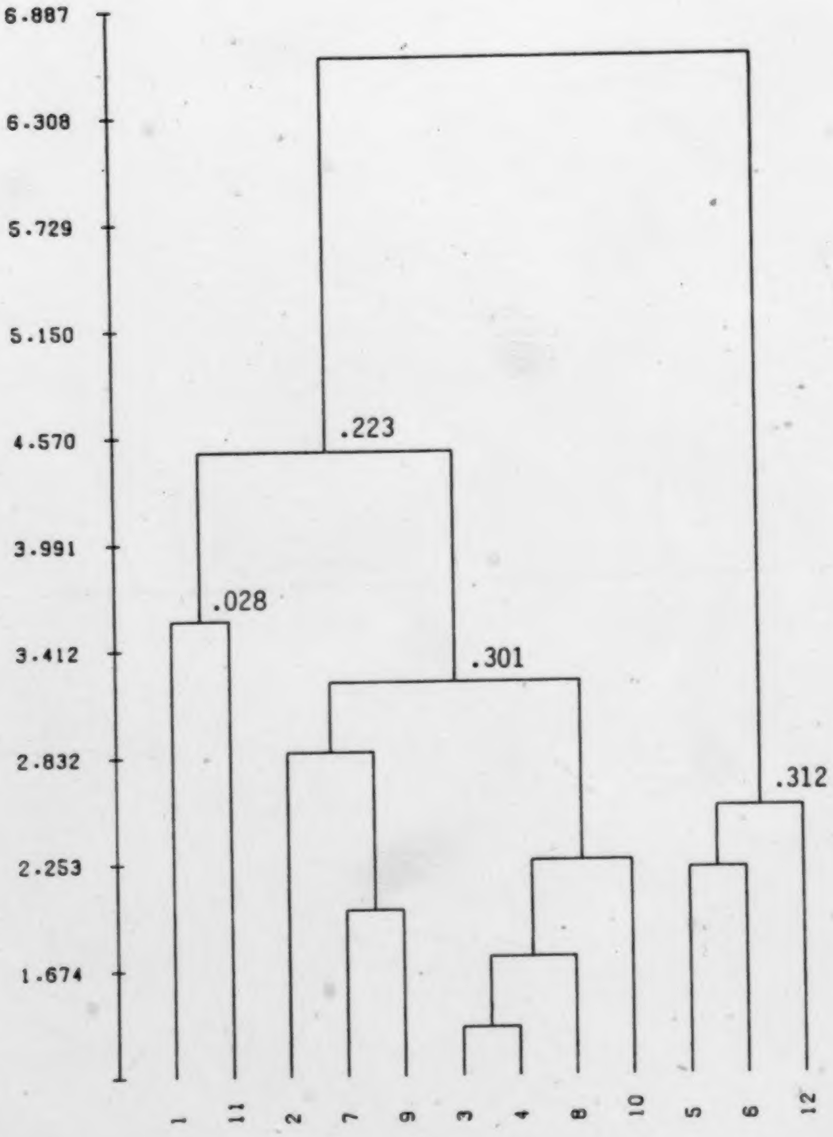

Figure 4.6. Aphasic Subject Profile Analysis: Words Modality

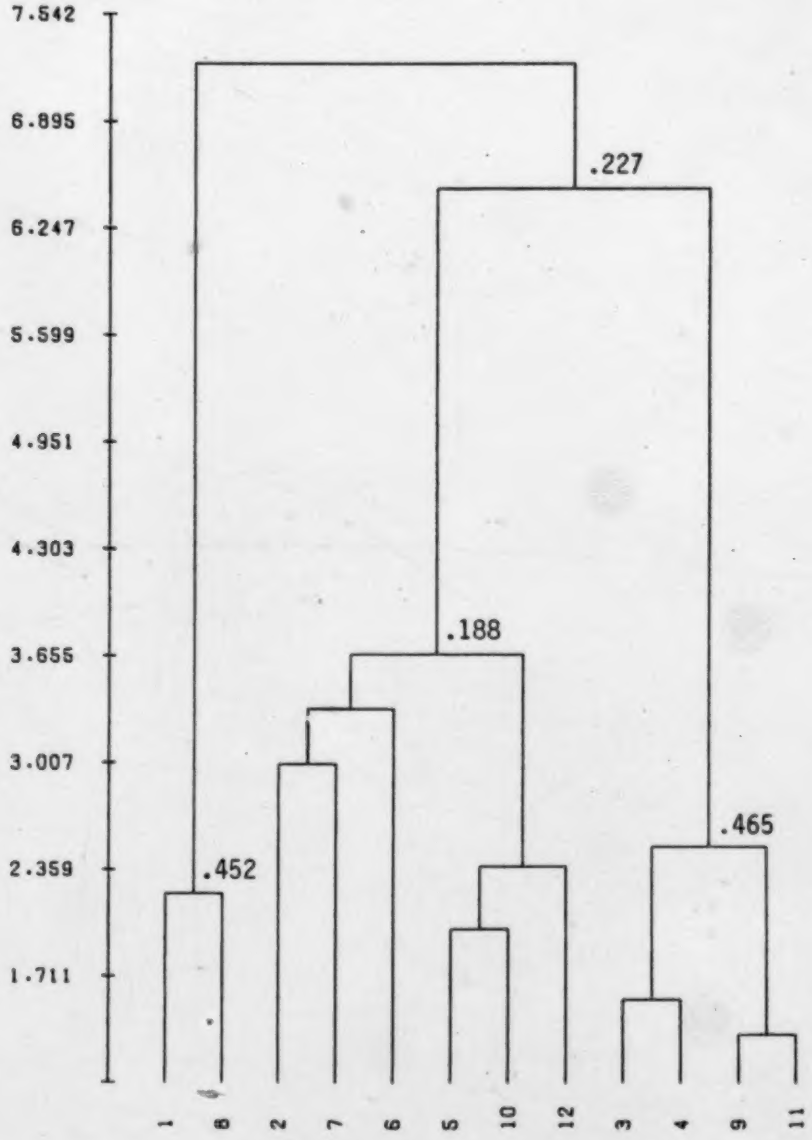

Figure 4.7. Aphasic Subject Profile Analysis: Real Objects Modality

only two subjects and the other, four. This absence of cluster cohesion indicates a weakness of common strategy or lack of a shared set of judgements among the aphasic subjects.

In summary, while the normal controls were apparently reasonably homogeneous in their similarity judgements in each of the three accessing modalities, the aphasics were not. This is hardly surprising, since aphasics may have very little in common with one another, apart from the fact that each has, as an adult, sustained brain damage. Acquired disorders of language are so diverse in both character and severity that little other than their underlying pathology may seem to link aphasics together. However, we will see in the analysis of the terms (the object analysis) that the judgements of the aphasic subjects were not so diverse as to yield an uninterpretable object structure or one unrelated to that produced by the control subjects.

4.2.2 Terms Analysis

Hierarchical clustering of stimuli was based on the data pooled across subjects within experimental and control groups, and within modalities. For each subtest, semantic similarity ratings were pooled across subjects in a group so that an averaged rating was derived for each pair of terms. These average values then served as data analyzed by the

Johnson's hierarchical clustering program. The pooled means and standard deviations matrices for each subtest for both groups are included in Appendix C.

Succinctly put by Baker & Derwing (1982), the similarity between terms or objects "is a function of the proportion of subjects who treated a particular set of objects in the same way: the number of subjects who, individually, did the same thing to a given item pair" (1982, p. 206). The hierarchical cluster analysis provides a display of the structure of these data which allows inferences to be made about the basis upon which subjects made their judgements, i.e., about the dimensions of meaning underlying the semantic set.

The number of relevant clusters for object data can again be checked by looking at the cohesion scores of each cluster generated by the cluster cohesion statistic, since the cohesion scores by their relative value indicate the intensity of bonding of a term into the hierarchical structure.

4.2.2.1 Normal Control Subjects' Object Clusterings

The object clusterings for the normal control subjects reveal a similar pattern of clusterings throughout the three presentations, and the structures produced by the hierarchical clustering analysis for each presentation are seen in Figures 4.8., 4.9. and 4.10. The semantic structure revealed by these dendrograms shows that (*broccoli*, *parsley*,

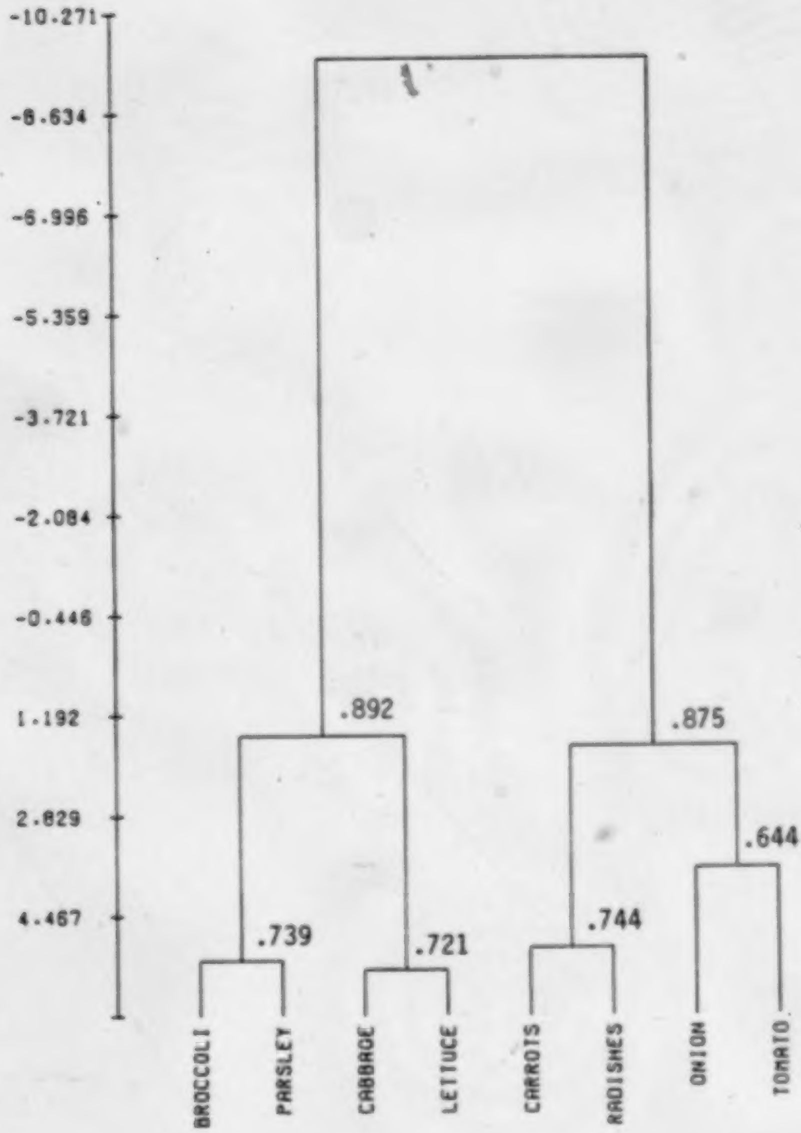

Figure 4.8. Vegetable Terms Clusters: Pictures (Normals)

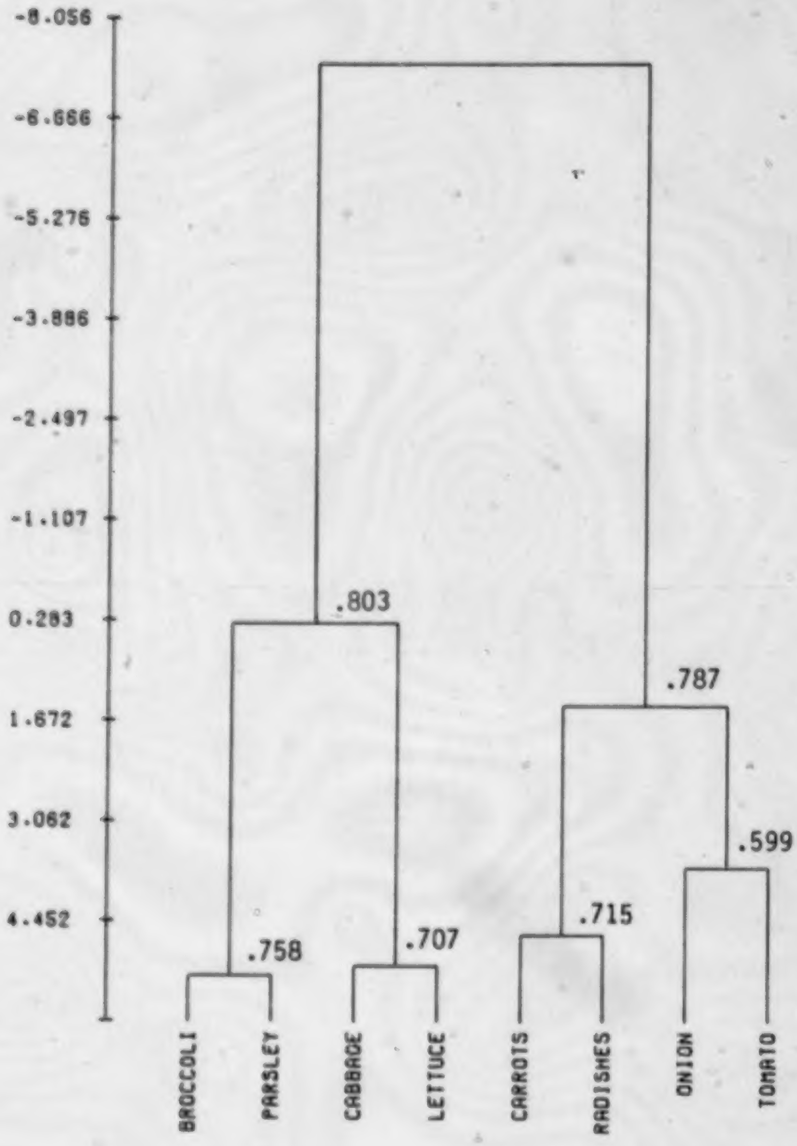

Figure 4.9. Vegetable Terms Clusters: Real Objects (Normals)

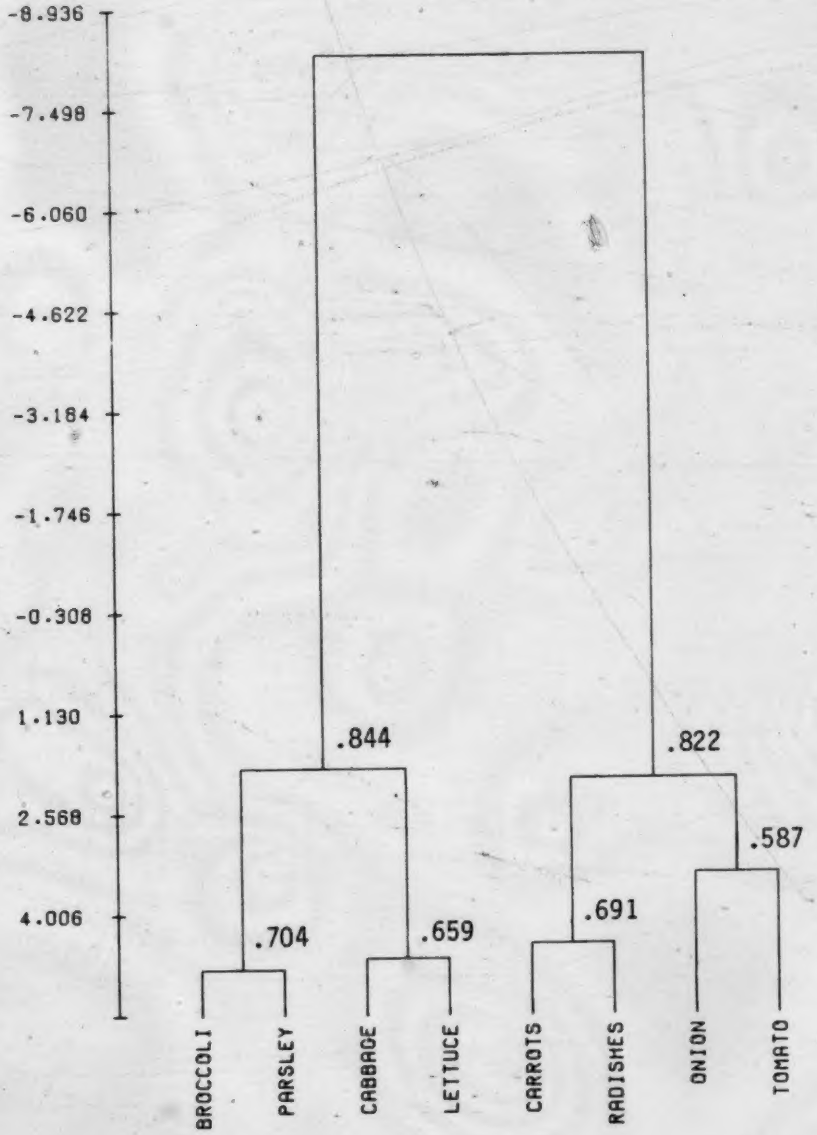

Figure 4.10. Vegetable Terms Clusters: Words (Normals)

cabbage, and *lettuce*) and nongreen vegetable terms (*carrots*, *radishes*, *onion*, and *tomato*). The green vegetables subdivide or subcluster further into "bunchy" (nonround) vegetables (*broccoli* and *parsley*) versus "nonbunchy" (round) vegetables (*cabbage* and *lettuce*). Likewise, the nongreen vegetables subdivide into bunchy vegetables (*carrots* and *radishes*) and nonbunchy vegetables (*onion* and *tomato*). In Figure 4.11. clustering results of the pilot study with normal controls employing the 9-point semantic similarity scale technique with the same eight vegetable terms, demonstrate an identical 2 cluster and 4 subcluster pattern as that found using the triadic comparison procedure in this study.

The cohesion scores for the three respective subtests, pictures, real objects and words for Cluster 1 (green vegetables) are .892, .803 and .844 and for Cluster 2 (nongreen vegetables) are .875, .787 and .822. In general, the scores for the green vegetables appear to be slightly higher than those for the nongreen vegetables, but this difference is not significant since in both clusters for the all three subtests these scores are well above the .4 requirement necessary to demonstrate good cluster cohesion.

Cluster 1 in each subtest subclusters into two set of pairs of vegetables, namely into the green (nonround), bunchy vegetables (*broccoli* and *parsley*) and green (round), nonbunchy vegetables. (*cabbage* and *lettuce*) with the following respective cohesion scores: .739 and .721

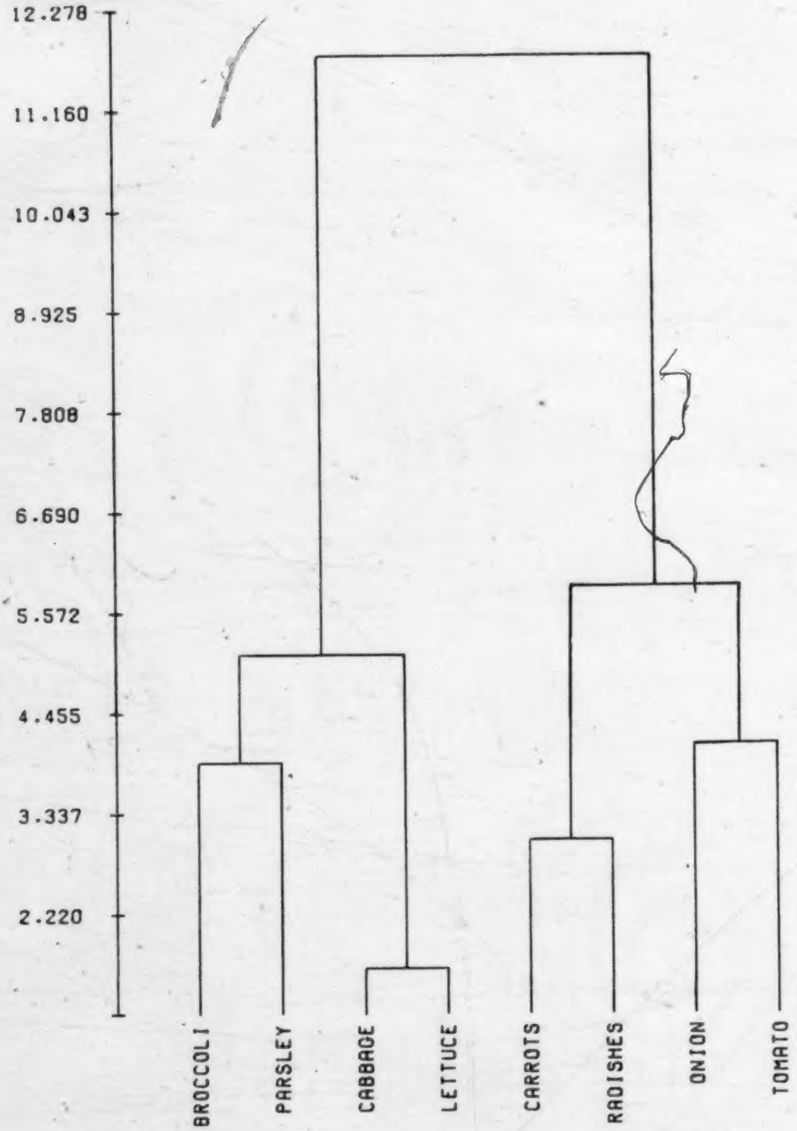

Figure 4.11. Vegetable Terms Clusters: Pilot Study

(pictures); .758 and .707 (real objects); and .704 and .659 (words). Cluster 2 in each subtest reveals the following infrastructures: *carrots* and *radishes* form the nongreen (nonround), bunchy pair of vegetables and *onion* and *tomato* the nongreen (round), nonbunchy vegetables with the following cohesion scores: .774 and .644 (pictures); .715 and .599 (real objects); and .691 and .587 (words). An overall comparison of the cohesion scores for the 4 cluster solutions shows that cohesion scores for the nonbunchy vegetables (the first set of cohesion scores) (*lettuce*, *cabbage*, *onion*, and *tomato*) are somewhat lower than those for the bunchy vegetables (*broccoli*, *parsley*, *carrots*, and *radishes*), which by their higher scores appear to be judged slightly more similar than their nonbunchy counterparts.

In summary, two main points regarding the terms clusterings for non-aphasic control subjects are manifested. First, although there is some variability among the cohesion scores across the three modalities, especially in regard to the nonbunchy and bunchy vegetables in terms of cohesion or distinctiveness of clusters, this variability really does not effect the interpretability of the scores, namely, that all the scores are well above the .4 criterion and thus indicate good cohesion. Second, either the 2 cluster solution or the 4 cluster solution is suitable in explaining the clustering of terms in this data for normal controls.

4.2.2.2 Aphasic Patients' Object Clusterings

Despite the indication, from the analysis of inter-subject differences, that the aphasic subjects lacked a strong common strategy in their respose to the object set, the decision was made to carry out a hierarchical clustering analysis on their data to see whether any reflection of the semantic structure exhibited by the normal controls could be detected. In fact, in many respects, there are similarities among the aphasic and non-aphasic control subjects' clusterings of objects, especially in the 2 cluster distinction between green versus nongreen vegetables. Aphasic subjects' object cluster structures are shown in Figures 4.12-4.14.

Interestingly enough, the infrastructures of Cluster 1 and Cluster 2 for the pictures subtest (see Figure 4.12) are identical to the normal control's object clusterings: the infrastructure of the first cluster shows *broccoli* and *parsley* paired together and *cabbage* and *lettuce* paired together, and in the infrastructure of the second cluster, the pairs *carrots* and *radishes*, and *onion* and *tomato* link together into a larger group of nongreen vegetables. For the real objects subtest (Figure 4.13), the infrastructure of the second cluster is different; in the nongreen set, the bunchy versus nonbunchy distinction is lost. Instead, *carrots* and *onion* form the nucleus as the most cohesive (i.e., judged most similar) pair, *radishes* is next added to the cluster by assessing it against the combined score of

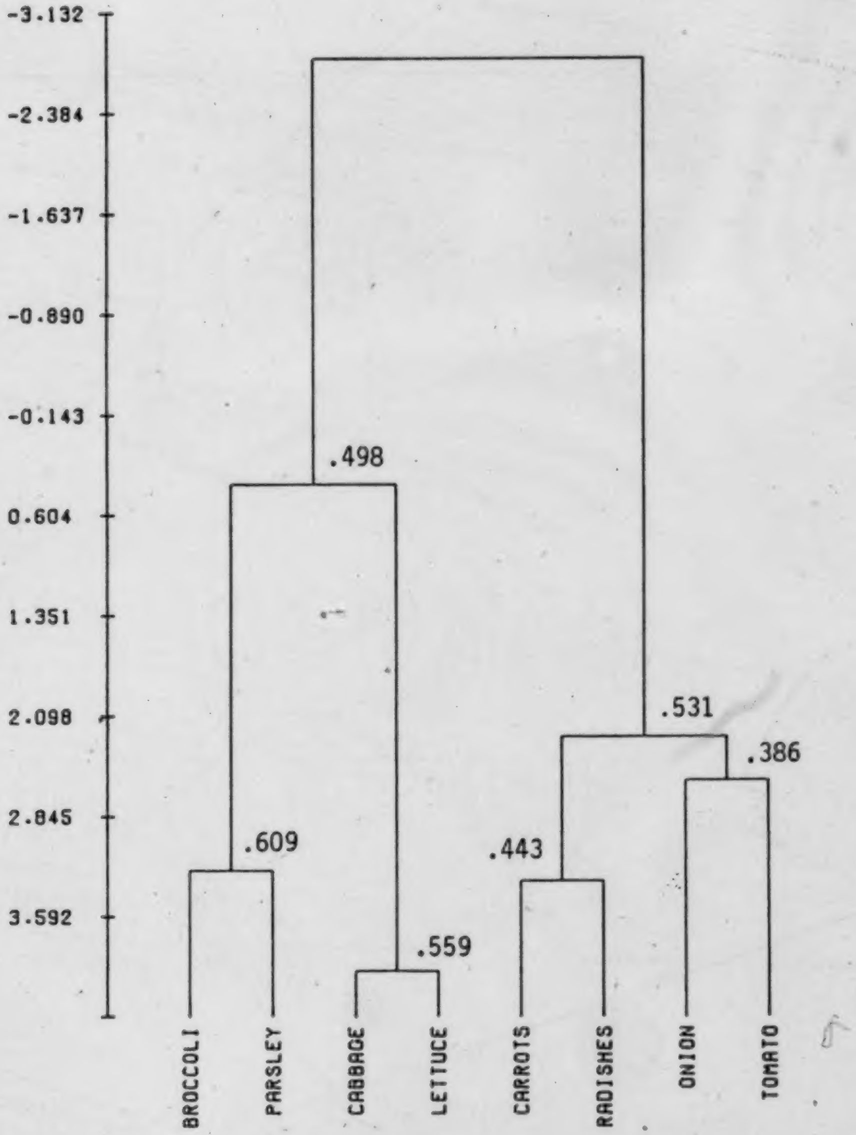

Figure 4.12. Vegetable Terms Clusters: Pictures (Aphasics)

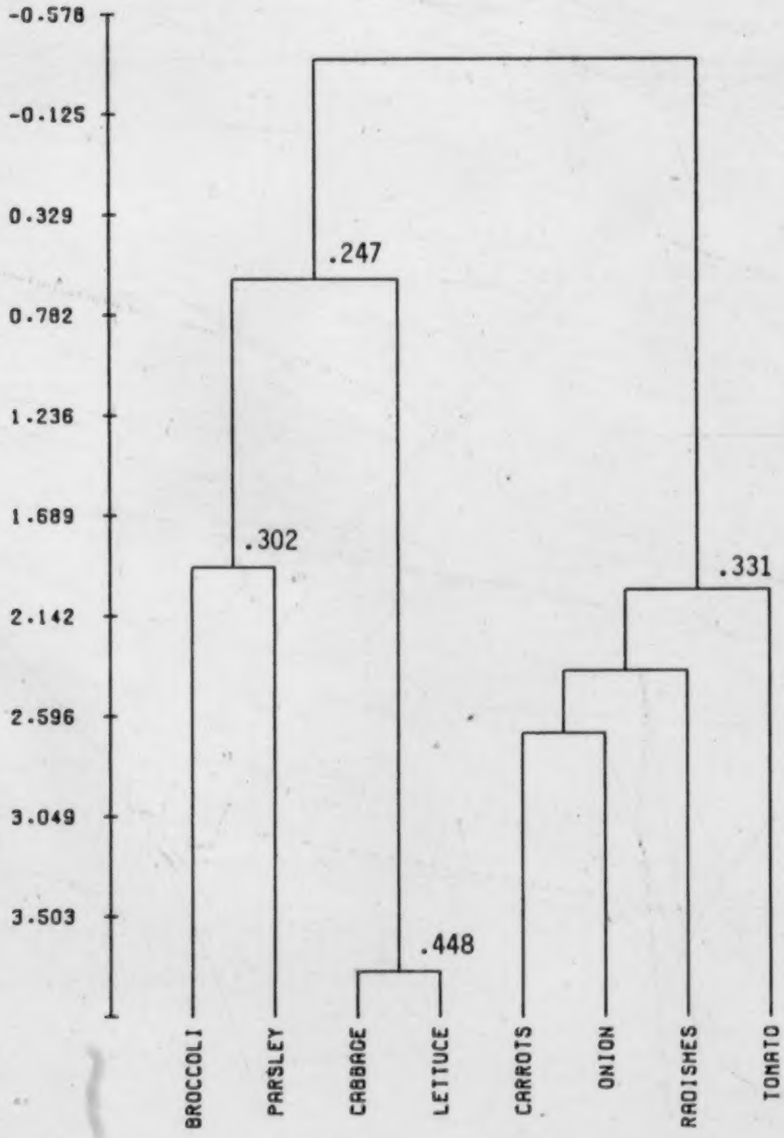

Figure 4.13. Vegetable Terms Clusters: Real Objects (Aphasics)

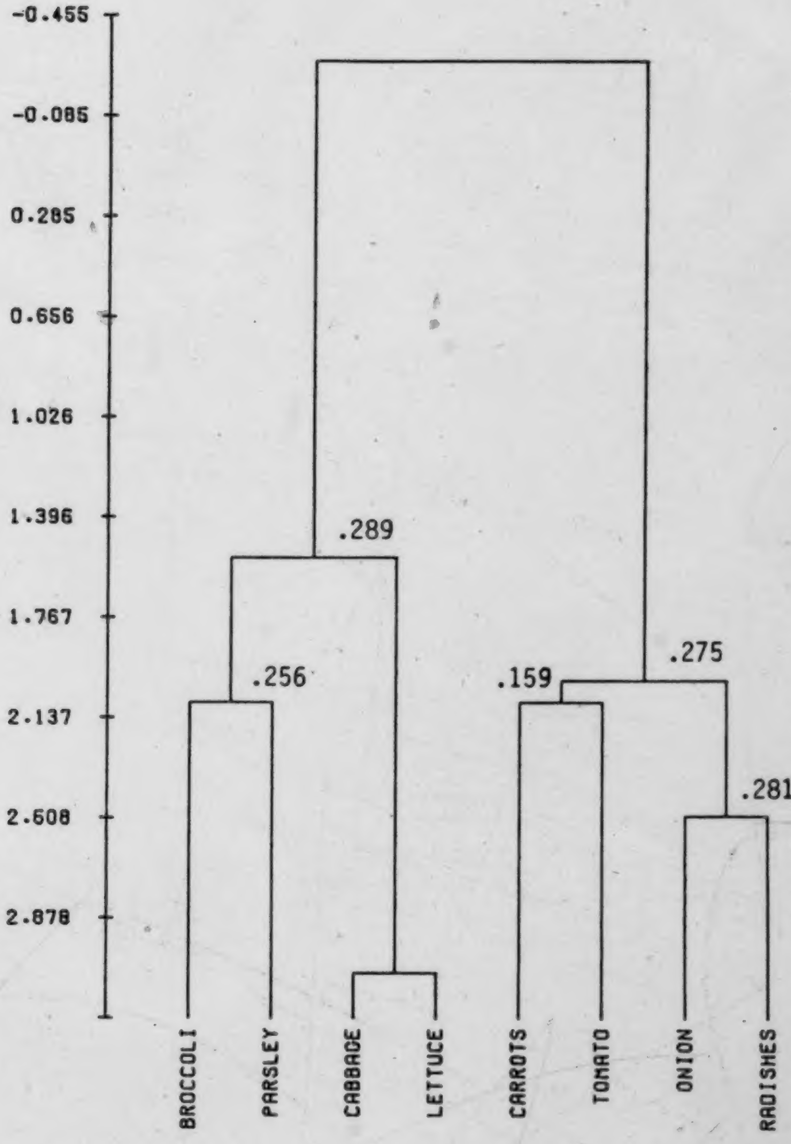

Figure 4.14. Vegetable Terms Clusters: Words (Aphasics)

the first pair, and last, *tomato* is added to the whole structure, thus forming the nongreen vegetable cluster whose cohesion score is .331. In the words subtest (Figure 4.14), although the two major clusters are maintained and even the pattern of four subclusters for that matter, the infrastructure of the second cluster is different from that of the normal controls' object clusterings and from the aphasic patients' pictures subtest object clusterings. The infrastructure of this cluster shows *carrots* and *tomato* paired together and *onion* and *radishes*, thereby eliminating in another fashion the bunchy and nonbunchy distinction in the nongreen set which is so apparent for aphasics' pictures subtest object clusterings and in all of the normal controls' subtests object clusterings.

However, despite the general overall similarity of the semantic structures produced by the aphasic subjects to those produced by the normal controls, it should be noted that the cluster cohesion scores in Figures 4.12-4.14 are, in almost all cases, markedly lower than those for the normals (cf. Figures 4.8-4.10), and many of the values for even the green/nongreen clusters are well below the .4 criterion figure. Only in the pictures subtest are there clusters with cohesion levels approaching that seen in the normal subjects data; words and real objects appear in almost equally diffuse structures.

In conclusion, while there appears to be a high degree of commonality in how normal controls treat the semantic set, both among subjects and across modalities, this is clearly less true with the aphasic subjects. While aphasics exhibit a certain general commonality of semantic structure across the three modalities, the overall diffuseness of their pooled semantic responses leaves us unclear as to whether this should be ascribed to such diffuseness within each individual, or to clear but differing strategies among individuals. It does, however, suggest that the aphasic subjects should not be treated as a pooled group.

Further, the analysis thus far does not tell us how consistent each individual subject, aphasic or normal, was in judgements made across different modalities. Some light is cast on this question by the results of the paired modalities comparisons discussed below.

4.3 Results of INDSCAL

Before reporting on the paired modalities comparisons, the results of an INDSCAL analysis will be presented. While they did not extend the findings of the hierarchical clustering analysis, they refined them using a second technique. The semantic similarity ratings for the subjects, both aphasic and nonaphasic controls, were analyzed using the INDSCAL program (Carrol & Chang, 1970), describe in detail in the previous chapter. The criterion for utilizing a multidimensional representation depends on the purpose for which it was generated. If the researcher is interested in the dimensions underlying psychological distance, as is often the case in semantic similarity judgement studies, then the fit of the spatial model to similarity data is a good criterion.

It was asssumed that INDSCAL results might provide additional information to that obtained from the taxonomic structures of hierarchical clustering. Figure 4.15. illustrates a two-dimensional INDSCAL solution of similarity judgements for the vegetable terms for the normal control subjects, by referring to the words subtest spatial representation as a typical example of the underlying dimensions revealed in the other two subtests. Dimension I again separates the vegetable terms into green and nongreen vegetables, while dimension II was again interpreted as the bunchy-nonbunchy dimension. The bunchy vegetable terms represent vegetables such as *broccoli*, *parsley*, *carrots*, and *radishes*; the nonbunchy vegetables are those such as *lettuce*, *cabbage*, *onion*, and *tomato*. In short, INDSCAL results validate the findings of hierarchical clusterings of objects in the three modalities for non-aphasic control subjects.

The semantic space obtained from the aphasic patients' real objects modality similarity matrix is schematically presented in Figure 4.16. It shows, as did the hierarchical clustering analysis, that only one interpretable dimension resulted from the multidimensional analysis of the data. This dimension was interpreted as the colour dimension:

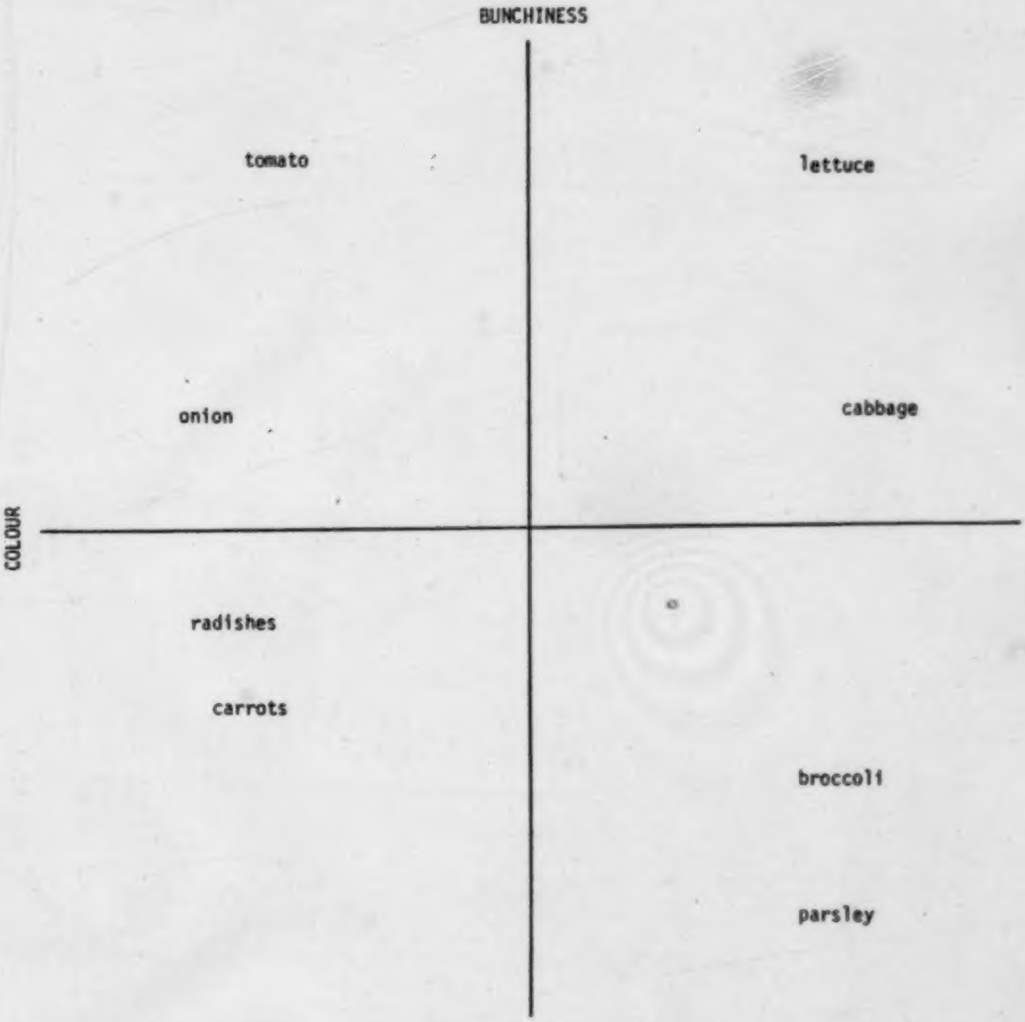

Figure 4.15. Vegetable Terms INDSCAL Solution (Words Modality) for Normal Control Subjects -- Colour and Bunchiness Dimensions.

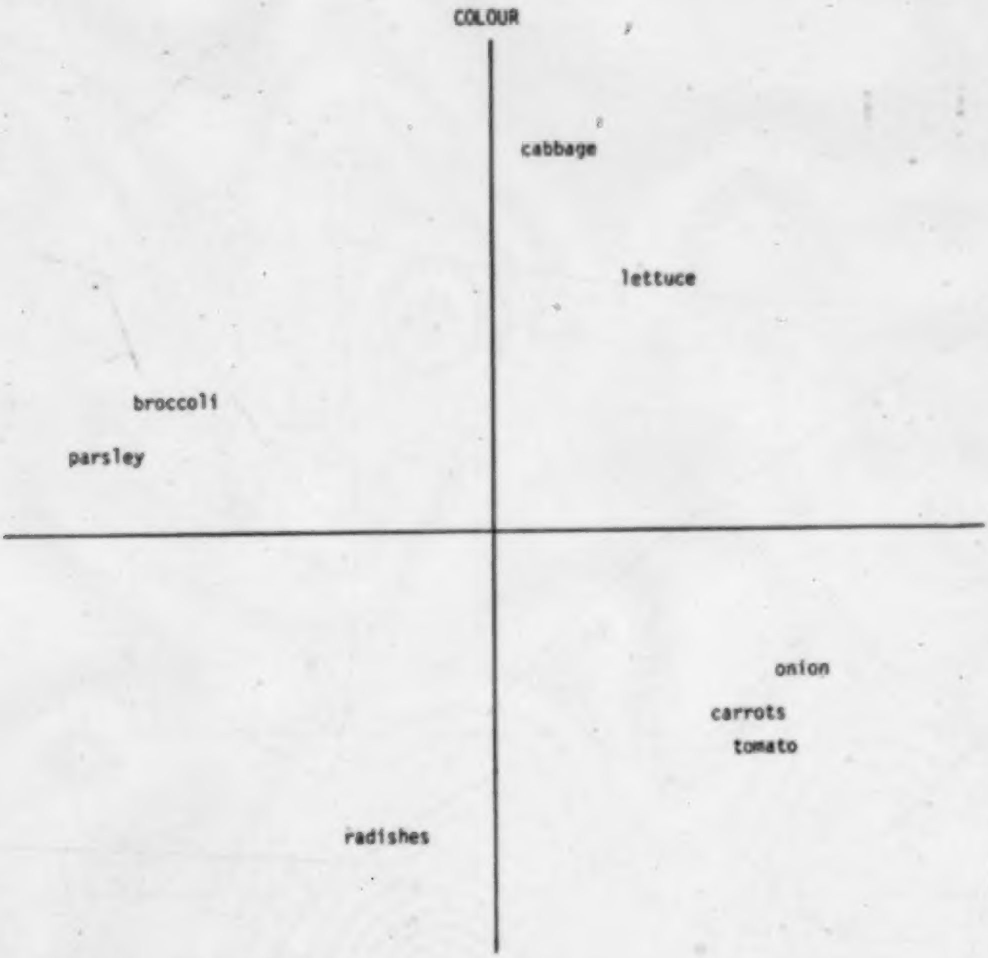

Figure 4.16 Vegetable Terms INDSCAL Solution (Real Objects Modality) for Aphasic Subjects -- Colour Dimension.

green vegetables like *broccoli*, *parsley*, *cabbage*, and *lettuce* were separated from the nongreen vegetables such as *carrots*, *radishes*, *onion*, and *tomato*. The second dimension of bunchiness again did not materialize at all.

4.4 Results of Paired Modalities Comparisons and ANOVAR

Paired modalities comparisons (PR; PW; RW) were computed as described above to examine individual subject data. These comparisons are displayed in Tables 4.1 and 4.2 for normal control and aphasic subjects, respectively, and graphically presented in Figure 4.17. These paired comparison figures give a measure of relative distance between the responses to any two modality subtests (pictures/real objects, pictures/words, real objects/words) for each individual subject.

Note that in general, the normal subjects' paired modalities scores tend to be lower than those for aphasic patients, as shown by the means for each column in Tables 4.1 and 4.2. This suggests that many aphasic individuals are less consistent in their judgements across modalities than are normal subjects. However, note also that some aphasics' scores are distributed in the normal range and vice versa. Figure 4.17 shows three cases of an aphasic paired distance score falling below the normal overall mean; however, a look at Table 4.2 shows us that these three scores belong to the same patient (Aphasic Subject 2), and

TABLE 4.1

Paired Modalities Comparisons: Distances Between Modalities for Normal Control Subjects (N=14)

Subject No.	P,R	P,W	R,W
1	9.16	7.14	4.70
2	6.16	10.15	6.48
3	5.83	8.00	5.10
4	7.48	6.32	7.55
5	5.20	4.24	5.38
6	6.32	4.69	4.24
7	3.46	4.00	3.87
8	6.32	4.80	7.75
9	4.90	5.29	3.32
10	6.86	6.78	6.24
11	4.70	3.74	4.24
12	4.00	4.90	3.00
13	7.35	4.24	7.35
14	5.10	5.48	6.16
	$\bar{X}$ = 5.92	$\bar{X}$ = 5.70	$\bar{X}$ = 5.38
	SD = 1.51	SD = 1.81	SD = 1.57

TABLE 4.2

Paired Modalities Comparisons: Distances Between Modalities for Aphasic Patients (N=12)

Subject No.	P,R	P,W	R,W
1	7.75	7.28	7.35
2	5.29	4.90	4.58
3	8.54	7.62	4.90
4	7.07	8.48	7.07
5	8.12	8.18	8.06
6	7.21	8.77	6.63
7	8.25	8.37	8.72
8	9.43	8.54	6.16
9	10.91	8.12	7.48
10	9.69	9.90	8.48
11	6.93	10.10	9.23
12	5.83	6.78	8.72
	$\bar{X}$ = 7.92	$\bar{X}$ = 8.09	$\bar{X}$ = 7.28
	SD = 1.61	SD = 1.38	SD = 1.50

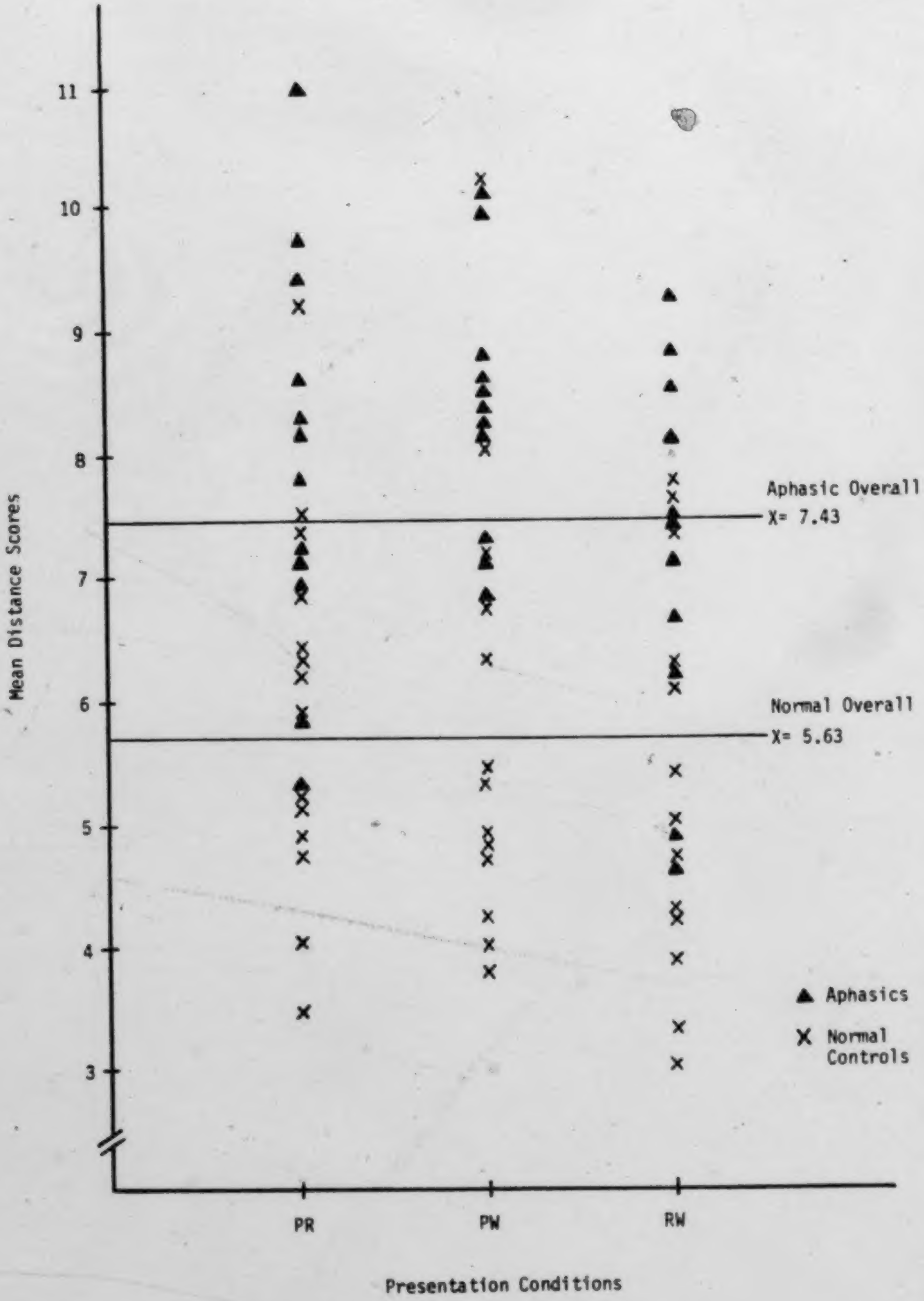

Figure 4.17. Distribution of the Paired Modalities Comparisons for Aphasic and Normal Control Subjects.

it is rather interesting to note that her low scores show that she was also consistent in her performance on all three modalities. Figure 4.17 also shows six examples of normal scores higher than the aphasic overall mean, attributable to five subjects (Control Subjects 1, 2, 4, 8, and 13).

An analysis of variance (2x3 factorial design) with repeated measures (ANOVAR) (Subject Group x Presentation Condition) on the Condition variable was performed on the paired modalities comparisons. It was performed to test for degree of differences between the performance of the aphasic and normal control subjects (between subjects comparison) as the first main effect; the difference between the three stimulus presentations or conditions (within subjects comparison) as the second main effect; and a possible interaction of groups and modes of presentation. All the variables and subjects were treated as fixed effects. The results of ANOVAR are shown in Table 4.3. This analysis revealed a significant main effect of groups, but no effect due to mode of presentation nor interaction between these factors. More specifically, this analysis revealed a significant difference among aphasic and normal control subjects (F=19.41; df=1,24; p<.001); a significant difference between anterior aphasics and normal controls (F=8.92; df=1,18; p<.008) and posterior aphasics and normal controls (F=16.12; df=1,18; p<.001), but no significant difference between anterior and posterior aphasics. In other words, while the aphasics (anterior versus posterior)

TABLE 4.3

Summary of Two-Way ANOVA with Repeated Measures on the Three Paired Modalities for Aphasic and Normal Control Subjects

SOURCE	DF	SS	MS	F	P
Between Groups					
Groups (A)	1	85.142	85.142	19.409	0.001
Error (Ss within A)	24	105.280	4.387		
Total	25	190.422			
Within Groups					
Presentation Type (B)	22	5.644	2.822	1.844	0.167
Presentation Type x Groups (A x B)	22	0.871	0.435	0.286	0.752
Error (B x Ss within A)	48	73.027	1.521		
Total	52	79.542			

did not differ significantly from each other in their treatment of the three modalities, they did, however, differ significantly from the normal control subjects. Since the overall effect of presentation conditions was insignificant within subject groups, but significant only between subject groups, no interaction effects were significant. Although the Groups x Presentation Conditions factors resulted in no interaction effects, it could very well be the case that if coupled with other factors like sex, age, educational level, languages known, etiology, current status, and severity, significant interaction effects might result. Figure 4.18 presents a graphic description of the Subject Group differences on the three paired modalities. It is interesting to note how similar this configuration is for the anterior aphasics and normal control subjects compared to posterior aphasics, and yet how the two groups differed considerably in their performance on the three presentation conditions.

To determine which paired modalities resulted in the differences between aphasics and normal controls, t-tests were applied to means in the data. Again, the comparison of the means reveals that aphasics and normal controls differed significantly in their treatment of the three modalities: PR: $t(24)=3.27$, $p<.003$; PW: $t(24)=3.82$, $p<.001$; RW: $t(24)=3.13$, $p<.004$. A comparison of the paired modalities means for posterior aphasics and normal controls reveals that there is indeed a difference between modalities, but

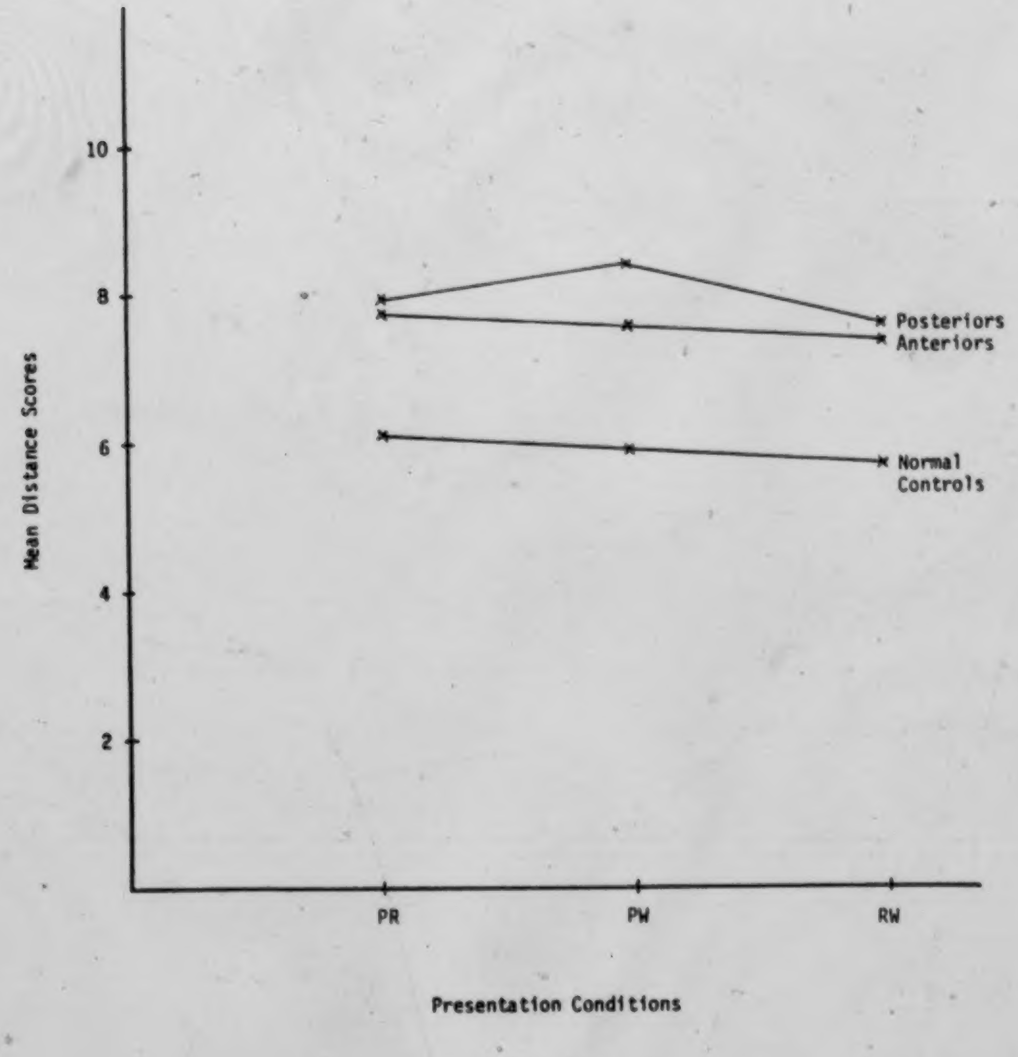

Figure 4.18. Groups Mean Distance Scores as a Function of Presentation Conditions.

only for the pictures-words comparison, significant at the .001 level. But for the anterior aphasics versus normal controls comparison, the probability is not small enough in any of the paired modalities comparisons to meet the conventional criteria and so the sample differences are not statistically significant. Interestingly enough, this .001 significance level for the pictures-words comparison is identical to the one obtained when aphasics and normal controls are compared. There is reason to believe that the difference between groups on the three modalities is attributable to the performance of the posterior aphasics (with more diffuse and aberrant scores), thereby resulting in significant differences between groups. This is illustrated by the fact that the pictures-words paired modality mean is somewhat higher for posterior aphasics (8.62) than it is either for anterior aphasics (7.56) or for aphasics grouped together (8.02), in comparison to the normal controls (5.10). In short, even though as a group aphasic patients differed from normal controls in their performance on the three presentation conditions, the greatest difference occurred between pictures and words, both levels of abstraction, but of different degree and nature, caused primarily by the performance of posterior aphasic patients.

It has been pointed out by Harasymiew, Hapler, and Sutherland (1980) that, in general, anterior aphasics average 10.2 to 11.5 years younger than posterior aphasics, are almost twice as frequently encountered as the posteriors, and that females have proportionately higher incidence of anterior aphasia than males (p. 197). Moreover, McGlone & Kertesz (1973) suggest that asymmetry of functions in language-usage organization and visual spatial functions may cause differences in performance between men and women, especially apparent under conditions of brain damage. In order to investigate differences in performance of aphasics on the presentation conditions, depending on variables such as sex (male, female), age (young: 15-40 years; middle: 40-65 years; old: 65 years and above), educational level (primary: Grades 0-7; secondary: Grades 8-12; college/university: above Grade 12), languages known (one or more than one), etiology (trauma, CVA, drug overdose), current status (acute, chronic), severity (mild, low-moderate, moderate, high-moderate, severe), means and standard deviations were computed under each variable for the respective paired modalities comparisons. These were computed only for aphasic subjects since irrespective of sex, age, educational level or languages known, normal subjects tend to perform very much alike on semantic similarity judgements, and since it has already been established by hierarchical clustering analysis and INDSCAL that they functioned as a homogeneous group in their strategies and treatment of the lexical items in all three presentation conditions. Table 4.4 clearly illustrates no large differences in mean or standard deviation values for

TABLE 4.4

Means and Standard Deviations of Paired Modalities for Aphasic Patients on the Variable Categories

No.	Variables	Type	Sample Size	PR Scores Mean	PR Scores Sd	PW Scores Mean	PW Scores Sd	RW Scores Mean	RW Scores Sd
1	Sex	Male	6	8.41	1.51	8.53	.93	7.60	1.18
		Female	6	7.42	1.68	7.64	1.69	6.97	1.82
2	Age	Young	2	7.48	.38	8.03	1.05	6.99	.51
		Middle	3	6.41	1.50	6.62	1.65	7.12	2.22
		Old	7	8.69	1.44	8.73	.92	7.43	1.54
3	Education	Primary	1	7.21	.00	8.77	.00	6.63	.00
		Secondary	8	8.07	1.61	8.40	1.14	8.14	.77
		College/Univ.	3	7.77	2.19	7.02	1.89	5.21	.84
4	Languages Known	Monolingual	6	6.95	1.20	7.31	1.39	6.54	1.56
		Bilingual	6	8.89	1.40	8.87	.89	8.02	1.09
5	Etiology	MVA	2	8.00	.35	7.83	.77	8.04	.97
		CVA	9	7.98	1.86	8.07	1.57	7.19	1.66
		Other	1	7.21	.00	8.77	.00	6.63	.00
6	Current Status	Chronic	7	8.26	1.82	7.63	.64	7.43	1.56
		Acute	5	7.68	1.54	8.41	1.71	7.17	1.57
7	Severity	Mild	3	7.67	1.80	7.53	.91	7.41	1.28
		Low Moderate	2	6.71	2.00	6.54	2.32	6.32	2.46
		Moderate	2	7.73	.74	8.57	.28	7.68	1.48
		High Moderate	2	9.12	.81	8.76	1.61	6.69	2.53
		Severe	3	8.30	2.26	8.90	1.05	7.93	1.15

the seven independent variable categories. However, it is highly possible that the independent variables interact among themselves and hence no one variable can be considered to be highly significant in the performance of aphasic subjects. Such an interaction of different independent variables could not be examined extensively in this study since the number of subjects was too small for computing ANOVAR. Likewise, since the sample size was small in many of the variable categories, t-tests could not be computed. In a larger study, site of lesion, sex, age, educational level, onset, etiology and type of severity might yet be found to interact with modes of presentation to yield significant results.

5. DISCUSSION AND CONCLUSIONS

5.1 Discussion

In this investigation of the underlying lexical structure of vegetable terms, the performance of aphasic patients has been compared to normal control subjects on a semantic similarity judgements task via three modes of reference.

5.1.1 General Comments

Given the findings of this study, several results should be commented upon. While the normal control subjects were consistent or homogeneous in their hierarchical clusterings of individual judgements of vegetable terms across the three accessing modalities, the aphasic patients were less so. This variability may be due to the fact that aphasics as a group were less certain of the basic structures underlying the vegetable terms in the real objects and words modalities. Given the fact that pathological populations (i.e., aphasic) have very little in common with one another apart from the fact that they have sustained brain damage to the left hemisphere, it is perhaps erroneous to attempt to pool aphasic subjects' data. Reliance on an individual subjective profile analysis may prove to be more constructive. Although aphasic subjects demonstrated some departure from normality in their object clusterings, they did not differ all that significantly from the normal control subjects, and there is no indication that their semantic-lexical structures of vegetable terms are drastically impaired. After making the general, gross distinction between green-nongreen vegetables, they tended to deviate from the normal control subjects' object clusterings. This is especially exhibited in the infrastructures of the nongreen vegetable terms for the actual objects and words modalities, where the bunchy-nonbunchy subdivision failed to emerge, the exception being the pictures modality. Note that this discrepancy is not evident in the green vegetables cluster across the three accessing modalities. It seems reasonable to attribute this phenomena to the fact that for the nongreen vegetables there is more variability in terms of redness than there is in terms of green-ness for the green vegetables, and more so with the actual objects than with the pictures of the objects; i.e., the nongreen set does not have a focal colour, but only the absence of green-ness, in common.

How is the mental representation for a category represented? Is it a word, an image or a list of properties? Can we say that one form of input (e.g., pictures) is more easily accessed (closer to meaning) than another (e.g., words)? The relative difference in difficulty in understanding pictures and words may result from the differential ease of accessing these various forms of information in the lexicon in the two forms of representation. The superority of pictures over words has recently been suggested by a number of investigators (Nelson, Reed, & McEvoy, 1977; Pavio, 1971; Pellegrino, Roskinski, Chiesi, & Siegel, 1977; Rosch, 1975), and is supported by data from a growing body of research collected under a wide variety of different conditions (e.g., decision latency, memory, naming latency, picture-word interference).

According to Pavio's (1971) dual coding model, pictures are better remembered than words in most tasks for one or both of two reasons. First, pictures are more likely to be dually coded than words (i.e., registered in both the image and verbal stores); and second, the image code, which is more likely to be stored to a picture than to a word, is the more effective code for item memory (Pavio & Csapo, 1973). For example, when subjects are instructed to form visual images of words and to name pictures (which presumably provide dual codes for both types of materials), recall performance is equal for pictures and words (Pavio & Csapo, 1973), although recognition performance continues to be superior for pictures over words under such dual-coding instructions (Snodgrass & McClure, 1975). Further evidence that pictures are more likely to be dually encoded than words, in the absence of instructions, comes from the finding that subjects have difficulty deciding between a studied picture and its name in a forced-choice recognition test (Snodgrass, Wasser, Finkelstein, & Goldberg, 1974) and from the lack of improvement in item recognition memory for pictures studied under verbal encoding instructions over those studied under imagery instructions (Snodgras & McClure, 1975)

The superiority sensory code hypothesis, proposed by Nelson and his colleagues, attributes the pictorial superiority effect to the more elaborate sensory codes of pictures as compared to words (Nelson, Reed, & McEvoy, 1977; Nelson, Reed, & Walling, 1976). First, pictures and words are assumed to differ in the order in which phonemic and meaning codes are activated. Words may activate phonemic features before they activate meaning features (although not necessarily), whereas pictures must always activate meaning features before they activate phonemic features. Second, pictures and words for the same referent are assumed to have the same semantic representation. Pellegrino, Roskinski, Chiesi, & Siegel (1977) have similarly suggested that words and pictures access the same semantic memory system, with pictures doing so more quickly.

There is some evidence supporting the general proposals of Nelson et al. and Pellegrino et al. Potter and Faulconer (1975), for example, found that pictures required more time to name and less time to categorize than words. Pellegrino et al. have also found shorter categorization times with pictures. That is, when subjects are asked to decide whether two stimuli are members of the same category, the decision can be made more rapidly for pictorial than for verbal representations (Pellegrino et al., 1977; Rosch, 1975). These studies it seems, strongly support the assumption that the phonemic information required in naming is more quickly accessed by words than pictures, and the conceptual information required in categorizing is more quickly accessed by pictures than words.

The two hypotheses discussed above, of course, are not mutually exclusive. It could be the case that both attributes of pictures, their greater probability of dual coding and their more elaborate sensory codes jointly account for the superiority of pictures over words in semantic processing. The degree of verbal coding of pictorial material is probably dependent upon both the complexity of the material and the task demands of the experiment.

In light of these findings, how can one account for the performance of aphasics on the real objects or words modalities, in relation to the pictures modality in this study? Pictures, in one form or another have been implicated in studies to examine specific visuo-spatial processes as well as more general conceptual abilities in pathological populations. Theoretically, aphasic patients are considered to have relatively well preserved visuo-spatial abilities. Aphasic disturbances are usually the product of left hemisphere lesions, whereas visuo-spatial deficits are thought to arise primarily from lesions in the right hemisphere. Even though pictures are a type of abstraction of the actual objects, they are, however, iconic representations of the real world objects, highly specific and heavily dependent upon their context (i.e, on their visual appearance), and use the same features as their external referents. In terms of time required to process the semantic similarity judgements in the respective modalities, it appeared to the experimenter that the pictures presentation required the least amount of effort on the part of aphasics to decode the relationships among the items of any of the three modalities. Perhaps it is the case that with regard to the pictures modality, the aphasics were responding predominately to the very salient colour dimension, rather than to any other perceptual cue or characteristic of the representation, and this being such a basic perceptual property remains undisturbed in aphasics with normal visual field perception.

In contrast, the real objects, a multi-sensory modality, involve several perceptual features, attributes or properties. The percept of an actual object is contrained by the object's stimulus properties (size, shape, smell, colour, feeling, sound, location and so on). The image is usually less vivid and less clearly experienced than the percept of an actual object. When confronted with multi-sensory stimulus properties, which may have caused more difficulty for aphasics in deciding upon the semantic similarity of vegetable items, the aphasic patients' selection was eventually restricted to the basic perceptual dimension of colour, although with less surety than when processing the colourful pictures.

Lastly, the words, regarded as the most advanced level of abstraction, are arbitrary derived codes (i.e., re-representations), with no necessary feature overlap with their external referents. They not only entail several aspects of word meaning simultaneously (i.e., acoustical, denotative, associative, and connotative), but also contain features which must be processed before the semantic features of the referent can be processed. The concept can be activated by auditory and visual verbal input and by referential stimuli. In this situation, one is uncertain about what words evoke, that is, whether mental images of the objects (i.e., pictures) or the actual objects with their perceptual/physical properties. In comparison to the other two modalities, impressionistically it seemed that the aphasic patients required the longest time to decode the semantic similarity judgements of vegetable terms presented in this modality.

Inasmuch as the anticipated difference in performance between aphasic and normal control subjects emerged based on an individual subject profile analysis, the other anticipated difference, namely, that between anterior and posterior aphasics on the three accessing modalities did not. Several explanations are offered to account for this phenomenon. It is highly possible that the lack of significant difference between anterior and posterior aphasics may be due, in part at least, to a sampling bias, since aphasic subjects who were too impaired to comprehend the demands of the experimental task were not incorporated in the study, as determined by their performance on the pre-test tasks. It would appear that the nature of this task requires a certain level of cognitive and linguistic functioning and processing to be able to perform satisfactorily on it, and so consequently, only high level aphasics were included in the study. It is hardly surprising then that this, in part, may have resulted in a insignificant difference between the two aphasic groups in their performance on the three presentations. While there is a difference between the aphasic and normal control subjects (as indicated by the ANOVAR results), there is reason to believe that the aberrant structures produced by the aphasic patients may have been caused in particular by the performance of the posterior aphasics, in relation to the normal controls subjects on the pictures and words comparisons.

It is noteworthy that other studies examining the semantic-lexical structure of concrete categories (concepts) and utilizing a much more heterogeneous set of stimuli (Epstein, 1975; Zurif et al., 1974) than those selected for this study, have found a significant difference in the performance of these two aphasic groups. Kelter, Cohen, Engel, List, & Strohner (1977) speculate that such a set of stimuli might be less sensitive to minor deviations than is true of tasks using objects from a limited class like vegetable or animal terms: "it is plausible that the discriminating features of this set of items are readily apparent and only the most disturbed patients would not order the items according to these prominent features" (p. 298). In their study, selecting a homogeneous set of stimuli chosen from the semantic set of animals, they found that both fluent and nonfluent aphasics produced structures that did not conform to that of normal controls. However, more recent studies utilizing Rosch's superordinate categories (e.g., birds, furniture, tools, fruit) revealed significant differences in the performance of anterior and posterior aphasic patients.

The studies mentioned above, including the present study, have demonstrated to various degrees that information about content words in anterior aphasics' "internal dictionary" seem to be less than normal. The entries in their lexicons seem elaborated more in terms of practical knowledge (like functions and perceptual features associated with the referents of words) than in terms of their lexically defining or sense features. In fact, the more salient a referent it has for different information channels (the more easily an object can be interacted via multiple sensori-motor modalities), the more easily that object can be named by anterior aphasics (Gardner & Zurif, 1975).

In addition, it has been frequently observed that anterior aphasics' difficulty with function words, long noted as one of the primary characteristics of their agrammatic output, is apparently reflected in their comprehension. A disturbance at the lexical level entails a loss of ability to evoke the content words (nouns, verbs, adjectives) of normal discourse while preserving the sentence structures in which these elements should be embedded; breakdown at the syntactic level is commonly referred to as agrammatism. Typically, in agrammatics' language production, many of the overt marks of phrase organization such as function words (e.g., articles, prepositions, pronouns, auxiliary verbs, and relational words and conjuctives) and certain classes of bound morphemes (e.g., -er and -est) tend to be omitted, and there is a corresponding reliance mainly on major lexical items, i.e., content words (nouns, adjectives, and uninflected main verbs). For instance, Zurif, Caramazzza, & Myerson (1972) in one study, required normals and agrammatics with intact comprehension to indicate the perceived relationship between function and content words by noting the words in sentences that formed the most closely linked pairs. Normals produced tight connections between articles and their nouns, while anterior aphasics linked the content words together and ignored the function words to a considerable degree, paralleling the omission of such words in spontaneous speech. In comparison to the normal control subjects, the aphasics more often grouped articles with verbs or with other articles, and correspondingly, less often grouped articles with their appropriate nouns. In other words, normal noun phrases (article plus noun) did not result, although aphasic patients were somewhat more successful in producing tightly bound noun phrases when possessive pronouns (*my shoes*) rather than articles (*the shoes*) were the function word members of the constituent.

In a further elaboration of this paradigm, Zurif, Green, Caramazza, & Goodenough (1976) verified the semantic qualities for function words somewhat more systematically. The data indicate that Broca's aphasics (anterior brain-damaged subjects with agrammatism, but intact comprehension), though insensitive to function words that mark the beginning of sentence structure (e.g., articles and pronouns) are relatively more sensitive to function words that convey semantic relationships (e.g., prepositions), whereas mixed Broca's aphasics (patients with agrammatism and comprehension deficits) were insensitive to prepositions in addition to articles and pronouns.

The fact that this particular class of words is selectively impaired in anterior aphasics with agrammatism cannot be explained in an obvious way, especially since there is considerable research evidence to support the observation that aphasic patients as a total population, show a reduction in vocabulary which is inversely related to the frequency of word usage. That is, words most difficult to retrieve (available to the aphasic according to the recognized lexical need) are those which occur least frequently in the language (Wepman et al., 1956). The individual's most common (frequent) use of a word is more likely to be retained than the least frequent use of the word.

Investigations of anterior aphasics' abilities to process function words have also shown that their memory for function words in the surface struture of sentences is significantly impaired relative to their memory for content words (Caramazza, Zurif, & Gardner, 1978). Since memory for lexical items is a function of the degree of processing or elaboration they receive at the time of processing, anterior aphasics' memory for function words will be poorer than memory for content words, the latter receiving more elaborate processing.

Apparently, the good auditory comprehension displayed by anterior aphasics is based chiefly on their ability to decode the content words of incoming messages, to apply word order strategies to the understanding of subject-verb-object relationships and to depend on context and real-world knowledge to extract sentence meaning with a high degree of accuracy. Unlike anterior aphasics' syntactic deficits, posterior (Wernicke's) aphasics less frequently use and understand content words in speech. In contrast, they show a profound impairment in comprehension of semantic attributes of lexical items (i.e., content words), reflecting either a deficit in the underlying semantic structure of the lexicon (Caramazza & Berndt, 1978;

Goodglass & Baker, 1976; Grober et al., 1980; Zurif et al., 1974) or an inability to retrieve semantic meaning of words (Milberg & Blumstein, 1981).

The content/function word distinction has also incorporated the division between open/closed class words. The open class, consisting of the major lexical categories of nouns, verbs, and adjectives is so called because new vocabulary items may be freely added as the occasion demands. The closed class vocabulary, in contrast, forms a restricted and non-productive set, and has a fixed relatively small membership containing elements of minor lexical categories (e.g., determiners, prepositions, pronouns, etc.), as well as bound morphemes (e.g., -ed and -'s). Bradley, Garrett, and Zurif (1980) have pointed out that the interpretative burdens of open and closed class items differ in an important way: open class items generally bear reference, while closed class items often primarily support analysis of sentence structure (i.e., are carriers of syntactic information). In the case of open-class words the reaction times of the normal subjects were found to vary with the frequency of the item in the language. The more frequent the word, the more rapidly it was classified. This, however, was not true for closed-class words, suggesting that in the intact brain the two vacabulary word classes are processed differently. In effect, apart from semantic forms of organization, the lexicon seems to be organized in such a way as to facilitate syntactic processing, i.e., to enhance access to information about features of sentence form. The anterior aphasics, on the other hand, failed to produce this processing distinction between the two vocabulary classes, although clearly recognizing words of both classes. Reaction times for both classes decreased with frequency. These results would suggest that the anterior aphasics have lost the specific retrieval system for closed class items, but not for the items themselves.

5.2 Suggestions for Further Research

The results of this study are only the tip of the iceberg in assessing the status of the semantic-lexical structure of aphasic patients via several modes of reference. Given the fact that there is some evidence for a contrast in production and comprehension for prepositions by anterior aphasics (with agrammatism), and reasons as noted above to distinguish the role of prepositions from that of other function words, this class of words would be worthy of investigation. These items are generally omitted in agrammatic speech, but they are, nonetheless, better processed than other function words in metalinguistic tasks (Zurif & Caramazza, 1976) and in comprehension (Goodglass, Blumstein, Gleason, Hyde, Green, & Statlender, 1979; Goodglass, Gleason, Bernholtz, & Hyde, 1972). Zurif & Caramazza (1976) suggest that this may be due to the fact that in contrast to other function words, prepositions encode semantic relations between nouns and verbs and thus may be processed by the support of semantic strategies. In preposition contrast sentences, the preposition is the only cue on which to base an interpretation of the role of the named individual either as a agent or a recipient of the action. When the preposition is critically important to assigning a meaning to a sentence, it is processed normally, but when the same function word is usually in a semantically less important way (as an infinitive marker), it is not processed normally.

A related but distinct rationale for such performance differences may be further seen by attending to the role of prepositions in the synstactic and phonological structures of English. Prepositions occupy an ambiguous position in the syntactic rules of phrase formation. They are lexical, viz., they head a major phrasal category, prepositional phrase, with the rest of function words. Kean (1979) has used this fact as part of an argument for the formal characterization of agrammatism as phonological. Briefly stated the observation is this: for speech error patterns which implicate the syntactic and logical structure of sentences, prepositions show error behaviour which is so comparable to that of other major grammatical classes, but for error patterns which implicate the sound structure of sentences, prepositions behave not with the major class, i.e., they do not contribute segments to sound exchange errors, though noun, verb, and adjective elements do. The finding that anterior aphasics are differentially sensitive to the same function words in different sentence constructions is crucial to determining the nature of the deficit experienced by these patients.

Secondly, further attempts to characterize the semantic structure of the subjective lexicon of other semantic domains such as emotion terms (a much higher level of abstraction than vegetable terms), to determine on what aphasics subjects based such abstract semantic judgements and whether they organize emotion terms beyond the basic pleasant-unpleasant dimension as do normal subjects (Magnera, 1982), would be insightful. Hemisphere differences have been examined in the expression or encoding of emotions, the processing of emotions and the perception or decoding of emotional stimuli. Some of this research investigating the representation of emotional functioning in the cerebral hemipheres has suggested a possible left-hemisphere localization for positive emotions and a possible right-hemisphere localization for negative emotions (Sackeim & Gur, 1978; Sackeim, Greenberg, Weiman, Gur, Hungenbuhler, & Geschwind, 1982). For instance, pathological laughing occurs two times more frequently in right-sided than in left-sided brain damage whereas pathological crying occurs more than twice as often in the left-sided than in right-sided damage. This relationship of the hemispheres with positive and negative emotions has further been supported by cases of positive and negative mood changes following unilateral brain insult and hemispherectomy.

Thirdly, it would be interesting to investigate the semantic-lexical structure underlying language use in aphasic subjects with regard to "smile" terms. Marckworth Stanford (personal communication), who has explored the semantic-lexical structure of such a semantic domain in normal subjects, has discovered that three interpretable dimensions resulted from the multidimensional scaling: (1) noisy (*roar*, *guffaw*, *laugh*, *chuckle*, *giggle*, *titter*, *cackle*, *snicker*, and *snigger*) versus quiet (or silent) smile terms (*simper*, *smile*, *grin*, *grimace*, *smirk*, and *sneer*); (2) pleasant (*roar*, *laugh*, *guffaw*, *giggle*, *titter*, *simper*, *smile*, and *grin*) versus unpleasant (or nasty) smile terms (*cackle*, *snicker*, *snigger*, *grimace*, *smirk*, and *sneer*); and (3) big (*roar*, *guffaw*, *laugh*, *cackle*, and *chuckle*) versus little smile terms (*sneer*, *grimace*, *smirk*, *giggle*, *titter*, *smile*, and *simper*).

Lastly, it would be constructive to incorporate children as another experimental group to observe their performance on such semantically-related lexical items, in relation to aphasic and normal adults. Already, it has been observed that young children's two-word utterances are analogous to telegrams. They are short, omit function words and represent meanings that adults would express with longer more complex sentences. During this period of two-word sentences, two form classes have generally been labeled pivot and open class words. The name of the former apparently derives from the fact that such words are fewer in number than open words and serve as pivot points around which the two-word sentence is organized. Moreover, the pivot class expands rather slowly, while the open class expands much more freely. In some ways, this distinction is reminiscent of the division between content and function words that occurs in adult speech. Though the two stages are by no means comparable, it is interesting to note the similarity of their class membership and function. For example, Rochford & Williams (1962) have found parallels at the lexical level between language acquisition and dissolution. They compared children and aphasics on confrontation naming tests and found that the names first learned in childhood were least likely to be lost in aphasia. The performance of children and aphasics was so close that the authors spoke of a "naming" age in anomic aphasia. In the case of naming and word retrieval, it is especially clear that a similar end product has been generated by qualitatively different processing in children and aphasics. However, for the aphasics, what needs to be more fully studied is the nature of the reorganization within the intact structures.

5.3 Conclusions

The issues addressed at the outset of this study have been examined in a comprehensive manner. The main findings of the present research can be summarized as follows. First, in organizing or structuring their lexicons on a semantic similarity of meaning task via three channels of processing, the aphasic and normal control subject groups did not differ all that significantly from each other in their clusterings of the vegetable terms. However, what is apparent is that in comparison to the normal control subjects, aphasics exhibited a fair degree of variation in their response to the nongreen vegetable terms in the real objects and words modalities. This is accounted for by somewhat less certainty and consistency on their part in performance when confronted with making similarity judgements to establish the relationship of these items to one another in their respective modalities. Second, the hierarchical clusterings of subject groups indicate that the two groups did indeed differ in the strategies they utilized when judging the similarity of vegetable terms, and furthermore, that aphasics failed to function as a homogeneous group in their response to the three presentation conditions. The fact that aphasics did differ from the normal controls may be attributable to the performance of posterior aphasics in particular, who in general tend to have more difficulty with content words than with function words, as measured by the pictures and words paired comparisons. The third finding to emerge from the experiment was unexpected and somewhat surprising especially in that it contradicted the earlier findings in the aphasic literature. Within the aphasic subjects, no clear relationship was found between impairment of semantic lexical level of language and clinical form of aphasia. In other words, anterior and posterior aphasics did not differ that significantly from each other on the similarity judgements of the vegetable terms under consideration. In any event, the results of the present study emphasize that the underlying semantic structure of vegetable terms across the three accessing modalities is more or less intact in both groups of aphasics, although there is some indication that this structure is much looser in posterior aphasics than it is in anterior aphasics.

It is rather unfortunate that in this study the interaction of several independent variables (sex, age, educational level, languages known, etiology, current status, and severity) could not be studied statistically because the number of subjects under each presentation condition was too small. A small number of subjects in a study can yield an inadequate "power" to demonstrate an association between two variables although one exists. For instance, graphic representations (configurations) of some of these independent variables, in particular, of etiology, current status, and severity in Figures 5.1., 5.2, and 5.3, respectively, reveal trends of possible interactions of

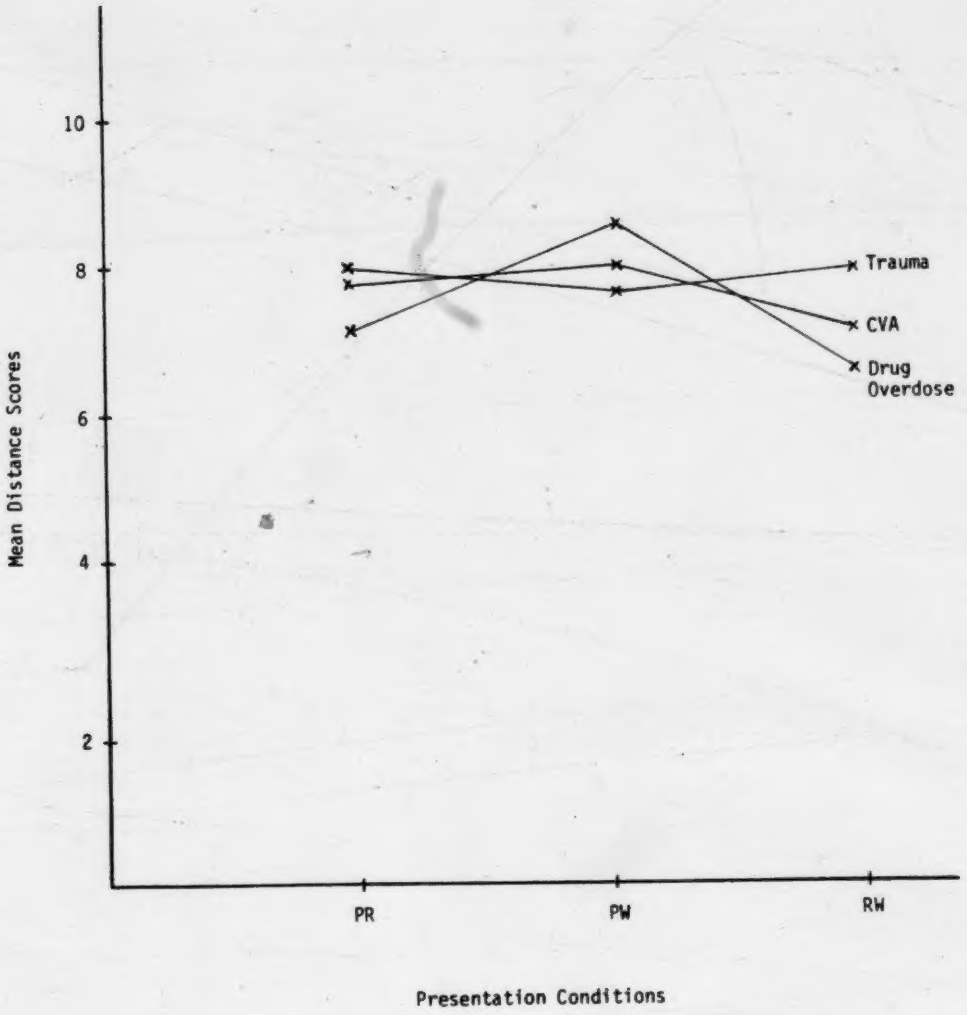

Figure 5.1. Etiology by Presentation Conditions Relationship

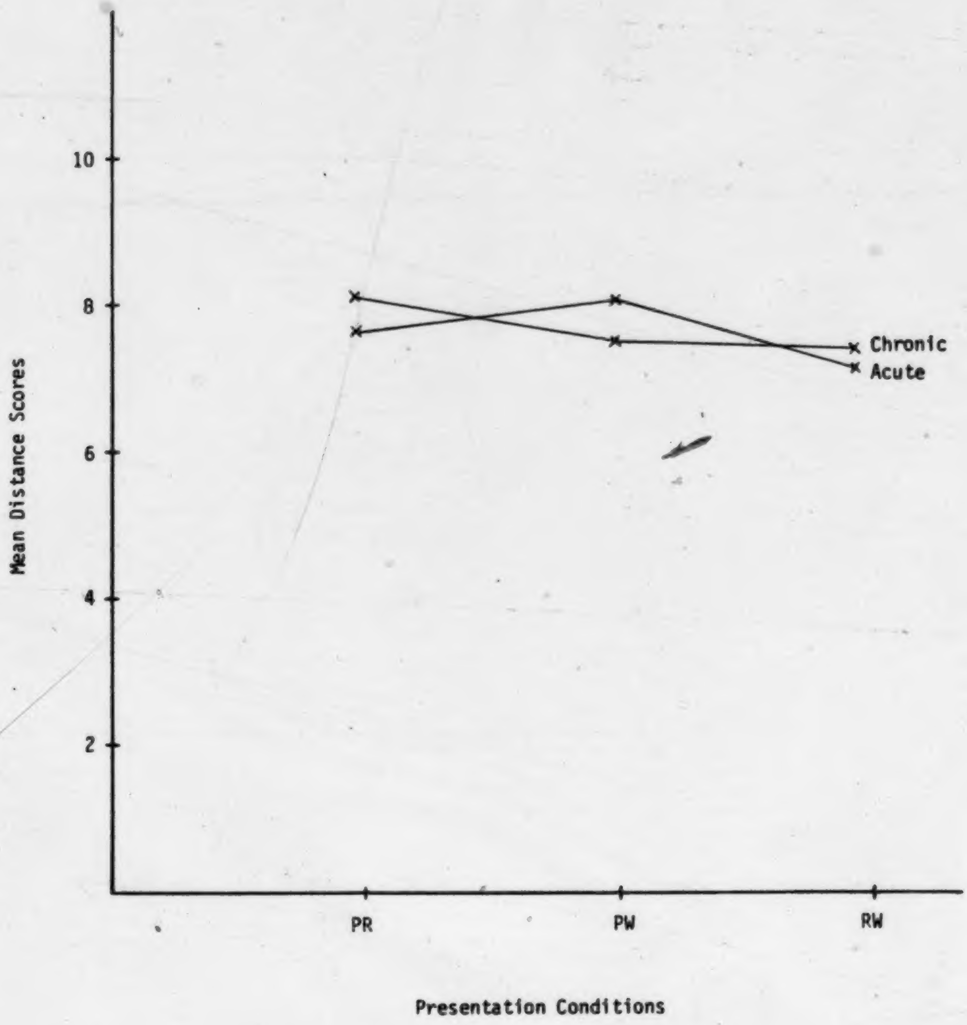

Figure 5.2. Current Status by Presentation Conditions Relationship

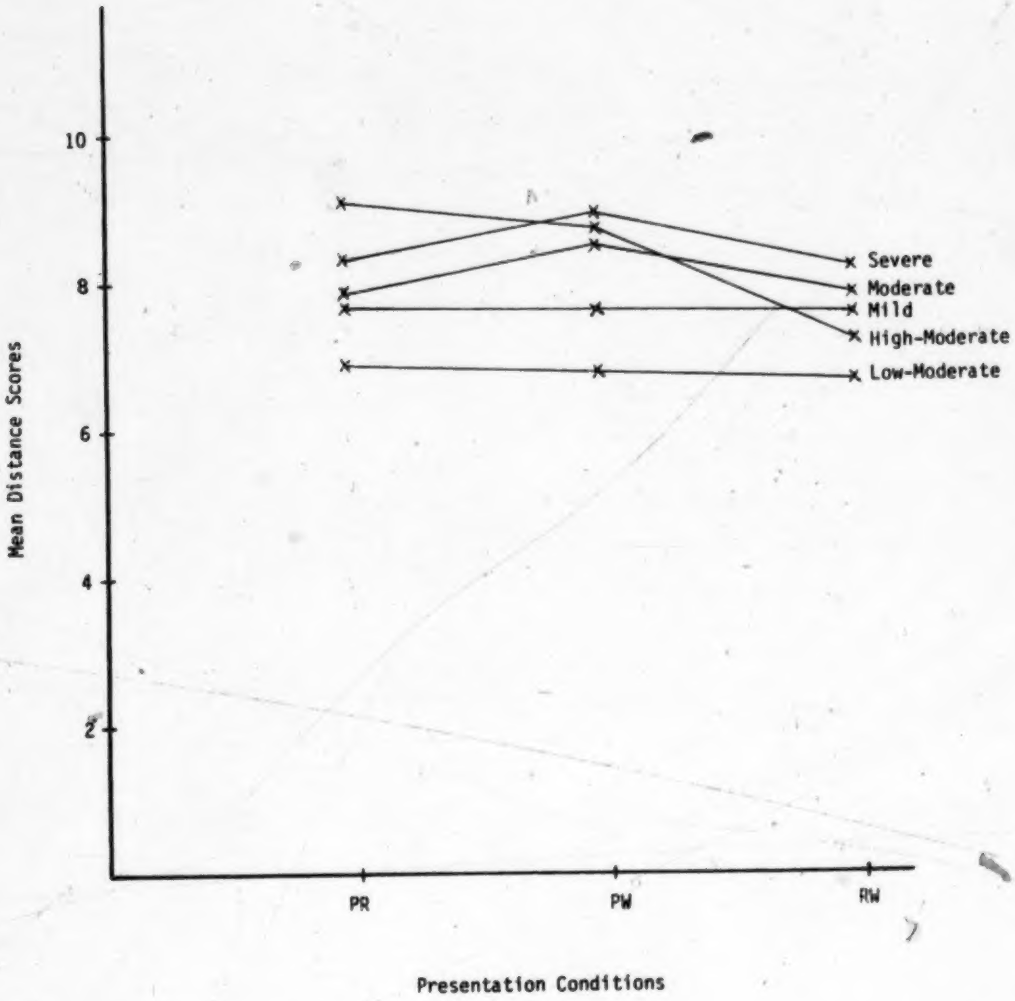

Figure 5.3. Severity by Presentation Conditions Relationship

these variables with presentation conditions. Clinical research has shown that in general, aphasic patients with brain damage due to trauma or drug overdose tend to show more diffuseness in their performance scores on comprehension tasks than do those due to cerebrovascular accidents. Interestingly enough, three of the six posterior aphasic patients included in the study were severely impaired and three were mildly impaired. A preliminary inspection indicates that the severely impaired posterior aphasic patients may have caused the between groups significant effect in overall performance of the posterior aphasic patients on the pictures-words paired modality. Thus, further research incorporating a greater number of subjects is necessary to establish the relationship of these factors to the three presentation conditions.

Despite some of the limitations listed above, this study has answered questions it set out to investigate, especially, given the fact that no information was available on how aphasic subjects might respond to semantically-related items on either pictures or actual objects modalities of presentation. The author feels that the results of this study have made a worthwhile contribution to the study of lexical semantics in aphasia.

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APPENDIX A

SAMPLE OF STIMULUS ITEMS USED IN THE PICTURES MODALITY

COLOURED PICTURES
Images en couleur

SAMPLE OF STIMULUS ITEMS USED IN THE WORDS MODALITY

carrots

APPENDIX B

TRIADIC COMPARISON ARRAYS OF VEGETABLE TERMS

1. broccoli
onion
parsley

2. carrots
cabbage
radishes

3. lettuce
tomato
onion

4. radishes
parsley
carrots

5. onion
carrots
broccoli

6. parsley
radishes
cabbage

7. tomato
radishes
broccoli

8. cabbage
parsley
broccoli

9. carrots
radishes
onion

10. parsley
tomato
broccoli

19. parsley
onion
carrots

20. carrots
onion
broccoli

21. lettuce
parsley
tomato

22. radishes
broccoli
onion

23. tomato
lettuce
cabbage

24. broccoli
radishes
carrots

25. onion
parsley
lettuce

26. cabbage
lettuce
broccoli

27. radishes
carrots
tomato

28. onion
cabbage
tomato

36. radishes
tomato
lettuce

37. parsley
cabbage
tomato

38. lettuce
carrots
broccoli

39. tomato
broccoli
onion

40. parsley
lettuce
radishes

41. broccoli
carrots
cabbage

42. radishes
onion
parsley

43. carrots
lettuce
cabbage

44. broccoli
parsley
radishes

45. tomato
onion
radishes

11. carrots
onion
tomato

12. radishes
lettuce
cabbage

13. tomato
parsley
carrots

14. lettuce
broccoli
radishes

15. cabbage
tomato
carrots

16. onion
radishes
lettuce

17. broccoli
cabbage
tomato

18. lettuce
radishes
carrots

29. broccoli
lettuce
onion

30. cabbage
radishes
tomato

31. parsley
broccoli
lettuce

32. onion
tomato
radishes

33. carrots
broccoli
parsley

34. cabbage
lettuce
onion

35. lettuce
cabbage
parsley

46. carrots
parsley
lettuce

47. radishes
cabbage
broccoli

48. cabbage
carrots
parsley

49. onion
broccoli
cabbage

50. onion
lettuce
carrots

51. broccoli
tomato
lettuce

52. cabbage
onion
radishes

The four missing triadic arrays are noted below in a footnote.[1]

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[1] 1. cabbage
carrots
onion

2. cabbage
tomato
carrots

3. carrots
lettuce
tomato

4. parsley
radishes
tomato

APPENDIX C

POOLED DISTANCE AND STANDARD DEVIATION MATRICES

APPENDIX C1: PICTURES MODALITY (NORMAL SUBJECTS)

SEMANTIC SIMILARITY MEAN DISTANCES

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	3.43	0.86	4.00	0.14	5.21	0.29	0.29
2	CABBAGE	3.43	0.0	0.36	5.36	0.43	3.07	0.29	0.93
3	CARROTS	0.86	0.36	0.0	0.29	2.86	0.50	5.00	2.21
4	LETTUCE	4.00	5.36	0.29	0.0	0.71	3.14	0.50	0.79
5	ONION	0.14	0.43	2.86	0.71	0.0	0.36	4.43	3.71
6	PARSLEY	5.21	3.07	0.50	3.14	0.36	0.0	0.14	0.07
7	RADISHES	0.29	0.29	5.00	0.50	4.32	0.14	0.0	2.64
8	TOMATO	0.29	0.93	2.21	0.79	3.71	0.07	2.64	0.0

SEMANTIC SIMILARITY STANDARD DEVIATIONS

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	0.94	0.86	0.88	0.36	0.89	0.61	0.73
2	CABBAGE	0.94	0.0	0.84	1.01	0.65	0.83	0.61	1.27
3	CARROTS	0.86	0.84	0.0	0.47	1.10	0.65	0.78	1.19
4	LETTUCE	0.88	1.01	0.47	0.0	0.73	1.23	0.65	0.80
5	ONION	0.36	0.65	1.10	0.73	0.0	0.84	1.09	0.83
6	PARSLEY	0.86	0.83	0.65	1.23	0.84	0.0	0.36	0.27
7	RADISHES	0.61	0.61	0.78	0.65	1.09	0.36	0.0	1.15
8	TOMATO	0.73	1.27	1.19	0.80	0.83	0.27	1.15	0.0

APPENDIX C2: REAL OBJECTS MODALITY (NORMAL SUBJECTS)

SEMANTIC SIMILARITY MEAN DISTANCES

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	2.93	0.64	3.14	0.57	5.21	0.29	0.50
2	CABBAGE	2.93	0.0	1.00	5.07	0.86	2.50	0.21	0.71
3	CARROTS	0.64	1.0	0.0	0.64	2.79	0.43	4.64	2.07
4	LETTUCE	3.14	5.07	0.64	0.0	1.29	2.36	0.57	1.64
5	ONION	0.57	0.86	2.79	1.29	0.0	0.57	3.71	3.71
6	PARSLEY	5.21	2.50	0.43	2.36	0.57	0.0	0.79	0.43
7	RADISHES	0.29	0.21	4.64	0.57	3.71	0.79	0.0	2.71
8	TOMATO	0.50	0.71	2.07	1.64	3.71	0.43	2.71	0.0

SEMANTIC SIMILARITY STANDARD DEVIATIONS

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	1.44	1.08	1.17	0.76	0.97	0.47	1.09
2	CABBAGE	1.44	0.0	1.11	1.21	0.95	1.22	0.43	0.99
3	CARROTS	1.08	1.11	0.0	0.93	1.25	0.65	1.22	1.27
4	LETTUCE	1.17	1.21	0.93	0.0	0.83	1.50	0.85	1.22
5	ONION	0.76	0.95	1.25	0.83	0.0	0.65	1.38	1.14
6	PARSLEY	0.97	1.22	0.65	1.50	0.65	0.0	1.19	0.85
7	RADISHES	0.47	0.43	1.22	0.85	1.38	1.19	0.0	0.73
8	TOMATO	1.09	0.99	1.27	1.22	1.14	0.85	0.73	0.0

APPENDIX C3: WORDS MODALITY (NORMAL SUBJECTS)

SEMANTIC SIMILARITY MEAN DISTANCES

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	3.64	0.43	3.57	0.50	4.79	0.86	0.29
2	CABBAGE	3.64	0.0	0.57	4.64	0.57	3.43	0.50	0.43
3	CARROTS	0.43	0.57	0.0	0.50	2.93	0.64	4.43	2.43
4	LETTUCE	3.57	4.64	0.50	0.0	0.93	2.64	0.57	1.64
5	ONION	0.50	0.57	2.93	0.93	0.0	0.36	4.07	3.43
6	PARSLEY	4.79	3.43	0.64	2.64	0.36	0.0	0.36	0.29
7	RADISHES	0.86	0.50	4.43	0.57	4.07	0.36	0.0	2.57
8	TOMATO	0.29	0.43	2.43	1.64	3.43	0.29	2.57	0.0

SEMANTIC SIMILARITY STANDARD DEVIATIONS

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	0.74	0.85	1.02	0.65	1.31	0.77	0.61
2	CABBAGE	0.74	0.0	0.65	1.22	0.85	0.85	0.52	0.65
3	CARROTS	0.85	0.65	0.0	0.94	1.00	1.01	1.28	1.22
4	LETTUCE	1.02	1.22	0.94	0.0	0.73	1.45	0.76	1.01
5	ONION	0.65	0.85	1.00	0.73	0.0	0.63	1.07	0.94
6	PARSLEY	1.31	0.85	1.01	1.45	0.63	0.0	0.50	0.61
7	RADISHES	0.77	0.52	1.28	0.76	1.07	0.50	0.0	0.85
8	TOMATO	0.61	0.65	1.22	1.01	0.94	0.61	0.85	0.0

APPENDIX C4: PICTURES MODALITY (APHASIC SUBJECTS)

SEMANTIC SIMILARITY MEAN DISTANCES

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	2.42	1.75	.42	0.67	3.25	0.67	1.00
2	CABBAGE	2.42	0.0	2.08	4.00	1.25	1.58	0.83	1.08
3	CARROTS	1.75	2.08	0.0	2.25	2.50	1.00	3.33	2.25
4	LETTUCE	2.42	4.00	2.25	0.0	1.25	1.58	2.33	2.08
5	ONION	0.67	1.25	2.50	1.25	0.0	0.83	2.92	2.58
6	PARSLEY	3.25	1.58	1.00	1.58	0.83	0.0	0.92	0.42
7	RADISHES	0.67	0.83	3.33	2.33	2.92	0.92	0.0	2.75
8	TOMATO	1.00	1.08	2.25	2.08	2.58	0.42	2.75	0.0

SEMANTIC SIMILARITY STANDARD DEVIATIONS

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	1.44	1.42	1.56	0.65	2.01	0.89	0.74
2	CABBAGE	1.44	0.0	1.44	1.21	1.14	1.00	1.11	1.08
3	CARROTS	1.42	1.44	0.0	1.42	1.24	1.28	1.78	1.22
4	LETTUCE	1.56	1.21	1.42	0.0	1.14	1.38	1.78	1.16
5	ONION	0.65	1.14	1.24	1.14	0.0	1.11	1.24	1.24
6	PARSLEY	2.01	1.00	1.28	1.38	1.11	0.0	1.00	0.79
7	RADISHES	0.89	1.11	1.78	1.78	1.24	1.00	0.0	1.06
8	TOMATO	0.74	1.08	1.22	1.16	1.24	0.79	1.06	0.0

APPENDIX C5: REAL OBJECTS MODALITY (APHASIC SUBJECTS)

SEMANTIC SIMILARITY MEAN DISTANCES

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	1.83	2.00	1.58	1.33	1.92	1.25	0.92
2	CABBAGE	1.83	0.0	1.92	3.75	1.58	1.83	1.50	1.25
3	CARROTS	2.00	1.92	0.0	2.25	2.67	1.17	2.67	2.42
4	LETTUCE	1.58	3.75	2.25	0.0	2.42	1.67	2.42	2.75
5	ONION	1.33	1.58	2.67	2.42	0.0	0.75	2.25	2.33
6	PARSLEY	1.92	1.83	1.17	1.67	0.75	0.0	0.92	0.83
7	RADISHES	1.25	1.50	2.67	2.42	2.25	0.92	0.0	1.83
8	TOMATO	0.92	1.25	2.42	2.75	2.33	0.83	1.83	0.0

SEMANTIC SIMILARITY STANDARD DEVIATIONS

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	1.53	1.71	1.83	1.44	1.16	0.75	0.51
2	CABBAGE	1.53	0.0	1.31	1.36	0.90	0.94	1.24	1.14
3	CARROTS	1.71	1.31	0.0	1.22	0.78	1.27	1.37	1.51
4	LETTUCE	1.83	1.36	1.22	0.0	1.73	1.30	1.62	1.42
5	ONION	1.44	0.90	0.78	1.73	0.0	0.97	1.42	1.23
6	PARSLEY	1.16	0.94	1.27	1.30	0.97	0.0	0.90	1.03
7	RADISHES	0.75	1.24	1.37	1.62	1.42	0.90	0.0	1.03
8	TOMATO	0.51	1.14	1.51	1.42	1.23	1.03	1.03	0.0

APPENDIX C6: WORDS MODALITY (APHASIC SUBJECTS)

SEMANTIC SIMILARITY MEAN DISTANCES

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	2.83	1.83	1.67	1.17	2.08	1.17	1.17
2	CABBAGE	2.83	0.0	2.17	3.08	1.08	2.00	1.33	0.75
3	CARROTS	1.83	2.17	0.0	1.42	1.92	1.25	2.33	2.08
4	LETTUCE	1.67	3.08	1.42	0.0	2.58	1.75	2.67	3.08
5	ONION	1.17	1.08	1.92	2.58	0.0	1.83	2.50	2.08
6	PARSLEY	2.08	2.00	1.25	1.75	1.83	0.0	1.17	0.75
7	RADISHES	1.17	1.33	2.33	2.67	2.50	1.17	0.0	2.25
8	TOMATO	1.17	0.75	2.08	3.08	2.08	0.75	2.25	0.0

SEMANTIC SIMILARITY STANDARD DEVIATIONS

		1	2	3	4	5	6	7	8
1	BROCCOLI	0.0	1.19	1.34	0.98	1.47	1.51	1.03	0.94
2	CABBAGE	1.19	0.0	1.19	1.68	0.79	1.35	0.98	0.75
3	CARROTS	1.34	1.19	0.0	1.00	1.08	1.06	1.23	1.24
4	LETTUCE	0.98	1.68	1.00	0.0	1.16	1.22	1.97	1.08
5	ONION	1.47	0.79	1.08	1.16	0.0	0.83	1.78	1.24
6	PARSLEY	1.15	1.35	1.06	1.22	0.83	0.0	1.11	0.97
7	RADISHES	1.03	0.98	1.23	1.97	1.78	1.11	0.0	1.14
8	TOMTATO	0.94	0.75	1.24	1.08	1.24	0.97	1.14	0.0